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WORLD CROPS

The International Journal of Agriculture

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A Publication of The Leonard Hill Technical Group

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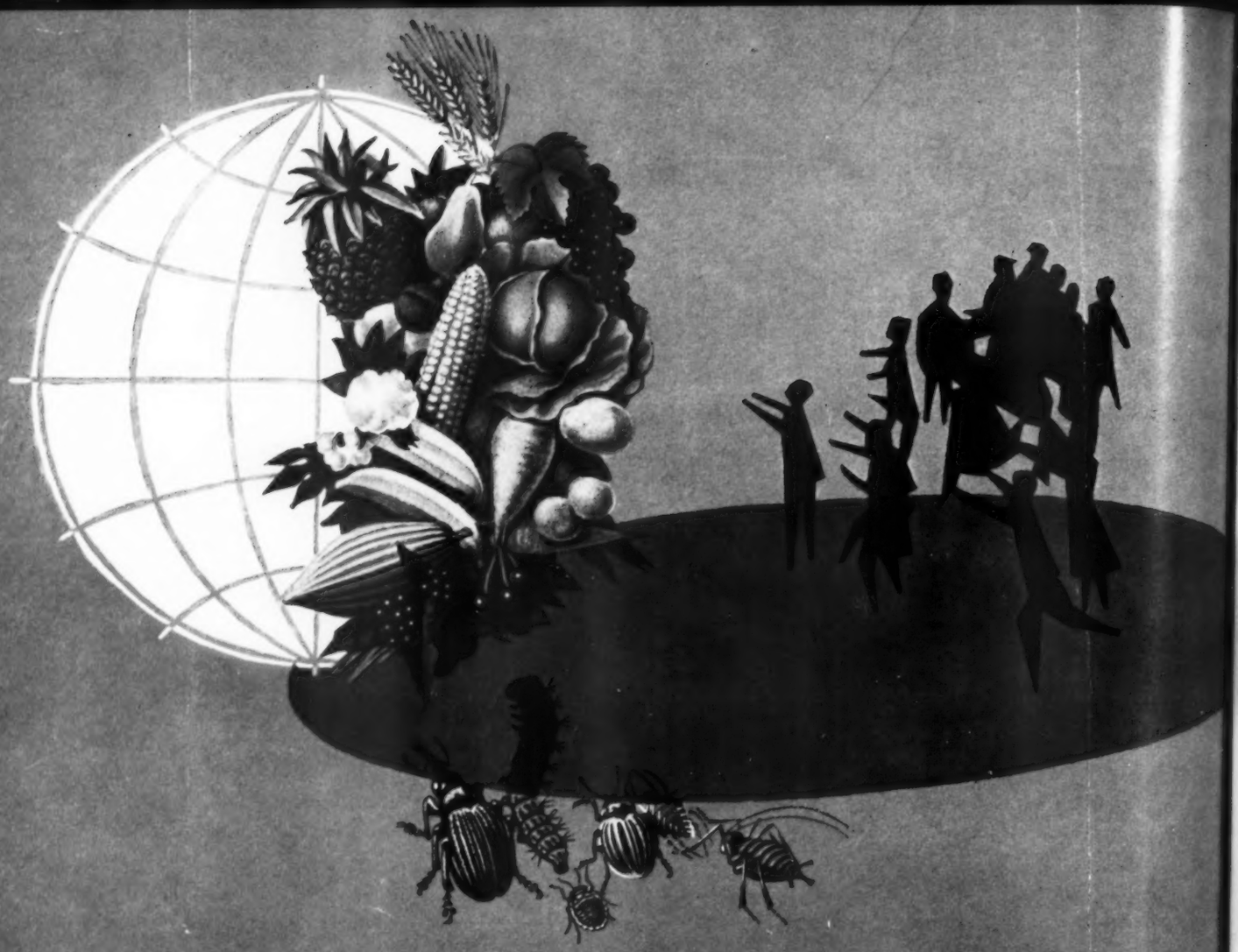

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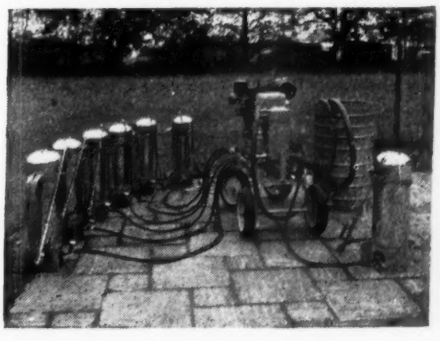

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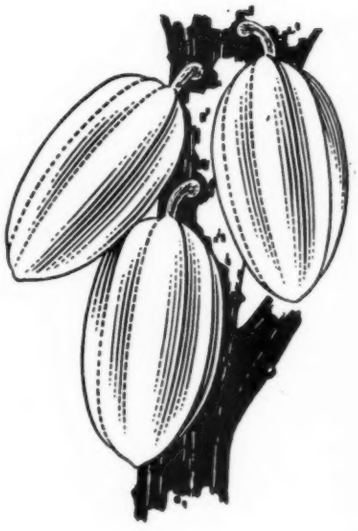

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Editorial Comment

Water resources

IT IS not generally appreciated that water, an essential plant nutrient, is also the limiting factor in population. This is quite obvious for the arid and the semi-arid regions of the world, but it applies also to the over-crowded and highly industrialised countries of Europe. An abundance of pure water is a major factor in the siting of chemical factories, textile and paper mills, breweries and distilleries. The new atomic power stations and hydro-electric power stations are also heavy consumers of water and the demand for more and still more power is constantly growing, with a doubling of output every 10 years.

It is now realised that higher yields of agricultural and horticultural crops can be obtained if rainfall is supplemented by irrigation water, applied at the right time and in the correct amount – too much water being as harmful as too little – but it is not for this reason alone that water needs to be carefully conserved. It is the first obligation of a water authority to provide enough water to meet domestic requirements and to see that these needs are met before considering the requirements of agriculture, for a single farmer, using water for ordinary canalised surface irrigation, might require as much as a quarter of a million of gallons of water a day for a part of the year – a supply adequate for the needs of a small town.

The demands for water by farmers and market gardeners might indeed become so great that they could not be met and the wasteful use of water needs to be prevented by having controlled systems of sprinkler irrigation and the use of instruments to indicate just when water is and is not required by the crop.

Writing in *Nature*, R. Maclagan Gorrie, a leading authority on soil and water conservation, stated recently that:

'The measurement of the flow of water, starting with surface run-off and finishing in the sea, can properly be considered the sphere of geographers skilled in hydrometry; the basic knowledge must needs include the ecology and geology of the catchment as well as the engineering of a gauging site, the best equipment for the given conditions, and the 'drill' for using the instruments properly. Too much of current press writings about floods and water resources shows a superficial approach. It is hoped that this may be counteracted to some extent by getting an increasing number of geographers using a scientific approach and, in close collaboration with the engineers, to undertake hydrometric work as well as climatological stations, and so build up a fuller knowledge of the nation's water resources'.

Saving water

THE EFFECTIVENESS of surface films of the waxy petroleum products, hexadecanol and octadecanol, in checking surface evaporation of water has been known for some years, but it is only comparatively recently that closer investigations in Australia and the U.S.A. have been made to assess the amount necessary to produce an effective film and to study methods of application and the effect of such chemicals on plant and animal life. It is claimed that hexadecanol is completely harmless to animal and vegetable life and, because the interchange of oxygen between air and water is not affected by the chemical, there are no ill effects on fish.

In the hot, dry areas of Australia, where stock depend for water on dams that hold rain-water, diminishing water levels are a source of worry to many farmers. In some areas dams are frequently replenished only once a year – during the winter rains – and much water is lost by evaporation during the hot summer.

For several years the C.S.I.R.O. has been experimenting to offset the effects of evaporation by the use of floats which carry cetyl alcohol. This spreads a film on the water and retards evaporation. Farmers who have used these floats are now enthusiastic about this form of water conservation, and some estimate that water losses have been cut by 50%.

Very great losses through evaporation occur in the tropics and semi-arid regions; thus on rice fields about 5 ft. of water will evaporate in a year. This method of water conservation has therefore considerable possibilities. Where water is scarce or its cost is high, the estimated cost of using the chemical does not appear to be excessive, but the matter needs further investigation. We therefore suggest that authorities in areas where water conservation is of great importance would do well to initiate experiments with these chemicals.

Reclaiming arid lands

THE PATTERN of agriculture in Israel is rapidly changing as a result of development of irrigation schemes. Dr. Hugo Boyko, head of the Ecology Department of the Agricultural Research Station at Beit Dagon, Israel, claims that a million acres of arid land in Israel can be transformed into pasture by irrigation with brackish or sea water. As the result of five years' experiments he states that land so irrigated is equal to that irrigated with fresh water.

We have always understood that, while the tolerance of individual crops for sodium chloride varies considerably and therefore no definite limit can be set for the amount of dissolved mineral matter which disqualifies water for use in irrigation, water with a higher total content of dissolved mineral matter than 100 parts per 100,000 cannot be safely used. We do not question Dr. Boyko's claim, but its importance for other arid countries is so great that we need further information on the technique employed.

Another method, which does not involve irrigation and which Dr. Boyko claims will make possible the

development of the fertile soils in the Negev arid region, is based on contour ploughing, resulting in conservation of rainfall sufficient to produce an annual crop of fodder in place of one crop in four years as at present. Using this method in rocky soil in Galilee, a yield of six tons per acre of fodder was obtained.

In view of the limited quantity of fresh water available, more attention is being given to spray irrigation, which makes better use of water than the furrow method, is easier to manipulate, but is more expensive. This system has mainly been used on small properties with market garden or orchard crops. It is extensively applied in citrus orchards in many countries, including Israel, but its application to annual field crops has hitherto not made much progress.

Experiments are now being made in Israel to use spray irrigation for rice cultivation. Rice is grown commercially in Israel, mainly in the well-watered Hulah Valley on the borders of Syria and Lebanon, but the amount of rice which can be grown in this region is insufficient to meet domestic Israeli requirements, so experiments on spray irrigation in the more arid regions are therefore justified. It has been shown that the amount of water required to produce a crop of rice under spray irrigation is only a quarter of that used by the inundation method. It appears to us doubtful, however, whether a field crop requiring as much water as does rice can be grown commercially in face of the high cost of water with the spray system.

Disposal of municipal wastes

THE COMPOSTING of municipal wastes has in recent years attracted increasing attention on the part of local authorities on the one hand, and gardeners, horticulturists and farmers on the other. To the one it offers a sanitary and economical method of disposing of the by-products of urban life; to the other it offers a supply of humus, or humus-forming material, where the methods of cultivation adopted do not conserve this essential element of fertility.

A Joint Working Party, under the chairmanship of Lord Douglas of Barloch, has produced an interim report on 'Municipal Composting – 1959', which summarises what is known and what has already been achieved in this field. Although the basic biological principles are well established, there remains much to learn about the large-scale composting of all kinds of animal and vegetable wastes.

It is known that night soil can be successfully composted with agricultural and municipal wastes and, whilst this procedure may represent the maximum conservation of waste organic material, the fact has to be accepted that, in urban areas, most sewage is disposed of by water carriage systems and is so heavily diluted that it is valueless for the manufacture of composts. The alternative offered is the residual sludge, produced in the ordinary sewage works.

Unfortunately, as Ferris points out in an article in this issue, this sludge is a relatively valueless commodity and, while this prodigal destruction of nutrient riches by controlled bacterial activity may be highly defensible on grounds of hygiene, it remains a prodigal waste which cannot be allowed to go on if our civilisation is to survive.

It has been said that the decline of Roman civilisation coincided with the introduction of water-borne systems of sewage disposal and the declining productivity of the fertile lands bordering the Mediterranean, which were reduced to desert by the effects of cumulative soil exhaustion.

By the same token Chinese agriculture is based on the effective utilisation of night soil, and in Malaya the market gardens which have been established on the inferior sandy wastes of abandoned tinfields are watered each day by 'gulle' or 'sock', drawn from a cess-pit beside the squatter's humble dwelling, and the resulting crops are of remarkable quality and quantity, even if they are quite unsafe to eat raw and uncooked. Nevertheless, it is on this agricultural economy that the biggest nation on earth has grown up and within 10 years will have a population of a thousand million.

Earth to earth . . .

CINNAMON, *Cinnamomum zeylanicum*, is a small evergreen tree, which, like tea, is grown as a coppiced bush. Native to Ceylon, it has the reputation of being a very soil-exhausting crop and, in fact, the production of cinnamon there is a dying industry, because of soil exhaustion without adequate manuring to renew the soil nutrients removed with the crop over a long period of years.

The plant in itself is really no more soil exhausting than any other crop; the method of harvesting is the root cause of the exhaustion of the soil, because, in effect, the whole of the plant is removed without any replacement of plant nutrients. The result is the bushes become weaker and smaller with successive cropping, and the organic matter in the soil gets used up or is burned away by increasing exposure to the heat of the tropical sun. Thus the soil becomes devoid of organic matter and microbacteria and of the major, minor and trace elements needed by plants. It has become almost pure silica.

These exhausted soils, known as 'cinnamon sands', are to be found mostly in the Negombo district of the Western Province of Ceylon. Never very fertile, these soils today consist of pure sand of varying depth overlying an impermeable clay pan; sometimes the subsoil consists of an impermeable black iron pan formed by the cementing of colloidal iron, organic and clay, washed down through this open-textured soil.

Owing to the nature of this subsoil, these soils become waterlogged in the rains and a system of deep drains is necessary to draw off the excess water,

wherever and whenever possible, to lower the water table and aerate the soil. It is also necessary to rehabilitate the soil if another crop, such as coconuts, is to be grown successfully. These soils are of very low fertility and in extreme cases are devoid of all plant life.

We were reminded of this by the death last month of Mr. R. Spencer Schrader, a prominent Ceylon planter and an acknowledged authority on the role of cattle on coconut estates, who has published numerous articles on the subject in Indian and Ceylon newspapers and journals. In his passing he directed that his body should be cremated and the ashes scattered over an area, formerly under cinnamon, which he had successfully rehabilitated and which now has a fine stand of 10-year-old Maldive palms in heavy bearing as a result of his efforts.

In addition to the application of mixed artificial fertilisers, he did everything possible to introduce life and organic matter into the soil and improve its nutrient status in respect of the 15 essential elements required for plant growth. This he did by bringing in and concentrating the plant nutrients from healthy areas in the form of coconut husks and farmyard manure produced in cattle byres under the litter system. In this formerly sterile and lifeless soil he was able to establish a nitrogenous green cover, *Centrosema pubescens*, which he turned in yearly as a green manure, and now finally he has given his ashes. ' Earth to earth, ashes to ashes, and dust to dust '.

E.F.T. or E.C.M.?

OTHERWISE EXPRESSED this means ' European Free Trade Area or Common Market?', which was the title of an address recently given by Mr. W. A. M. Edwards, Chairman of the Committee on the E.F.T. Area of the Association of British Chemical Manufacturers, to a packed meeting of the London Section of the Society of Chemical Industry.

In 15 months, he said, the conception of the Common Market has grown from an embryo into a lusty child, but there seemed to be little immediate prospect of the family being increased from the six nations of the Common Market by the adoption of the 11 nations outside so as to establish a European Free Trade Area.

So far as Britain was concerned, it would mean a loosening of Commonwealth ties, if all commodities were to be included in the Free List, so it had been proposed to exclude agricultural commodities, but this was not acceptable to the six.

General objections by the 11 were a danger of the dumping of large quantities of cheap mass-produced goods in those countries which were not in a position to compete on equal terms because of the small size of their industries or their lack of necessary raw materials or power. This obviously would lead to the permanent degradation of their depressed areas.

One of the most vital objections, however, has been the difficulty of defining the ' origin ' of a finished product, for it would be possible by a trifling amount of processing to convert a nearly finished product or a costly raw material produced outside the E.F.T.A. into a tariff-free commodity (see WORLD CROPS, 1958, **10**, 393).

11-Nation talks

WHILE WE were assured in Germany that that country is in favour of the establishment of the Free Trade Area, and it was considered that it would do nothing but good, France, on the other hand, is not so willing to co-operate. Britain is now taking part in important new negotiations to prevent Europe from being split into two competing trade blocs and to provide a bridge between the six nations of the Common Market and the 11 outside it. The initiative came from two European governments and the talks, now at official level, have two main objectives: (1) To increase trade between the European Powers outside the Common Market and thus cushion the effects of discrimination, either direct or indirect, against them.

This is a reasonable precaution to safeguard the export trade of the 11 nations from losses which might become serious.

(2) To promote common aims and policies and greater unity among the 11, who were formerly linked with the old concept of a Free Trade Area. This would provide a basis for a renewed approach to the Common Market organisation.

By these negotiations it is hoped that, instead of mutual discrimination and retaliation, a basis may yet emerge to preserve the economic and political unity of Europe.

Corrosion comes to town

SPEAKING SO soon after the announcement of tax changes in the Budget, Sir Owen Wansbrough-Jones, Chief Scientist of the Ministry of Supply, struck a topical note when he remarked at the opening of the Corrosion Exhibition that the cost of corrosion to Britain was equivalent to 2*s*. in the £ on the standard rate of income tax. This was based on the widely-quoted estimate that corrosion costs Britain £600 million a year, an estimate that Sir Owen found slightly unbelievable, but which, so far as we know, has not been challenged.

Whatever argument there may be about the magnitude of corrosion costs, there is no doubt that corrosion does a great deal of damage in more subtle ways than direct destruction. It is responsible, for instance, for losses in reliability, extra wear on agricultural equipment and extra costs of maintenance. Sir Owen thought that scientists might well give more attention to the maintenance of reliability by proper corrosion prevention.

Sir Owen praised the organisers of ' this large and admirable exhibition ' and, indeed, his description of it was strictly accurate, for it was probably the biggest exhibition of its kind ever to be held in Europe, perhaps in the world. The New Hall of the Horticultural Society in Westminster was packed with the displays of some 80 exhibitors and the large attendance convincingly demonstrated that the exhibition has made a permanent niche for itself in the calendar of technical exhibitions.

The exhibitors – large and small – deserve praise for their skilful exposition of the gospel of corrosion technology, and it is clear that there will be keen interest in the next exhibition, which, as in the case of the 1957 and 1959 shows, will be organised by our associated journal, *Corrosion Technology*. Firms wishing to participate in the next exhibition will be advised of the time and place and all enquiries should be addressed to *Corrosion Technology*, 9 Eden Street, London, N.W.1.

Aid for agriculture

A WELL-KNOWN FINANCIER, having bought an agricultural estate, found among the rubbish the seat and the debris of a very old combine harvester. Being an expert at tax saving, he approached a well-known tractor firm and said he wanted them to recondition this agricultural implement and take advantage of the Government grant for the reconditioning of obsolete equipment.

' *I think we've* really *got something this time, chief* '

What this amounted to was the supply of a new and modern combine harvester, specially modified to take the old seat, which because of the change in designs was slightly more costly than the new harvester.

He was able to convince those concerned that the seat was indeed an essential part of the machine and the transaction was carried through to the satisfaction of the buyer, the seller and the Government, who granted the usual subsidy for improvements.

Pennywise

I love to lose myself in other men's minds. When I am not walking, I am reading; I cannot sit and think. Books think for me.—Charles Lamb, ' Last Essays of Elia '.

Reading technical literature is part of the scientist's job and it is fallacious to think it can be dodged. Therefore we approve of the American Chemical Society's series of advertisements which ram home this simple, inescapable duty. There is a great complaint that there are too many technical journals. Of course, there are more than there were 10 years ago, and in 10 years there will be more still, but this is a consequence of the rapid expansion of knowledge. New sciences, new technologies and new industries demand new vehicles of information.

When people complain that there are too many technical journals it is because they have not bothered to get their reading organised. It is no good relying on the company librarian to select articles to be read and, very often, expect him to produce so-called ' time-saving ' digests. The scientist who lets a librarian read for him is also letting him think for him.

Some organisations carry this pennywise policy to the extent of having their librarian make photostat copies of articles for circulation to their staff. Time and money could be saved by taking out a few extra subscriptions, thus ensuring that the staff get their essential reading promptly and in good condition. Individuals could help by buying a WORLD CROPS themselves, for one issue costs less than a packet of cigarettes.

We recently visited the library of a large chemical factory in Europe, where all the scientific and technical journals for the year were arranged in neat piles, covering the January to May issues, but WORLD CROPS was nowhere to be seen. In response to our natural enquiry, we were informed that this journal was in such high demand that it was never in the library, but always out on loan. Similarly in many other large concerns, such as research institutes, there is usually a single copy which is circulated, is difficult to trace when required, and may be delayed for months before it again gets back to the librarian. Obviously two copies are necessary, with one for permanent retention in the library. (Order Form, see page A48.)

Man-Made Rain

Overhead Irrigation of Tea

T. E. ROGERS, M.B.E.*

It is apparent from this article that if artificial rain is applied to tea in areas which are subject to drought yields can be very materially increased. The cost is considerable, but the figures show that the expenditure is more than justified.

A FILM was shown recently at the British Council Theatre in London to illustrate the overhead irrigation of tea in the Amluckie Estates in the Norogong District of Assam in India. The first part of the film showed how the water was brought to the estate along concrete and masonry channels a total distance of about four miles and distributed over the 1,000 acres of the estate through 6-in. aluminium piping. The second part of the film showed this water being precipitated over the tea bushes at the rate of 445 gal. per min. through large rainers with an actuating water pressure of 100 lb. per sq. in. at the nozzles. Each of the machines was irrigating with man-made rain a radius of 183 ft., and it precipitated the equivalent of ½ in. of rain over 2½ acres of tea in one hour.

A Sigmund R4 rainer operating over shaded tea

Total cost

This was only a part of the project; the remainder is now nearing completion and present indications are that the capital cost of the installation will be in the vicinity of Rs. 400.00 or £30 per acre. Due to the great distance that the water has to be carried to bring it to the estate, approximately 40% of the expenditure has been on account of the construction of the concrete and masonry channels and of the necessary siphons and culverts. The cost of these is approximately Rs. 9.00 or 13*s.* 6*d.* per running foot. These channels, or flumes, are designed to carry from 35 to 45 thousand gal. per hour and their total length is about four miles.

Because the tea areas in this estate are widely dispersed, and because the water is obtained from two rivers roughly seven miles apart, this estimate of Rs. 400.00 per acre is higher than the cost of high-pressure irrigation would be where the estate is more compact and the supply of water is closer to the estate.

The pump is the heart of an irrigation system. Here a Marlowe pump is seen distributing water over the crop through a manifold system

* Technical Consultant, Empire of India and Ceylon Tea Co. Ltd.

Water flowing along a concrete channel and entering an inverted siphon to pass under a railway track

Increased yields

An area planted in October–November 1949, which has been irrigated annually since planting, yielded, in 1955, 18½ mds.† per acre. A nearby area, planted in October–November 1948, which was beyond the range of the installation, yielded, in the same year, only 11½ mds. per acre. Beyond the fact that one area was irrigated annually whilst the other was not, all other factors were equal. At the end of the six years there were many more ' vacancies ' in the unirrigated area.

Labour requirements

The estate's labour requirements are based on a formula which the writer evolved several years ago, namely, 1.5 labourers per acre, for a yield of 13 mds. per acre, ± .05 labourer per acre for each maund above or below this figure. Thus an estate with an average yield of 11 mds. per acre would, on this formula, require 1.5 labourers per acre, less .05 labourer × 2 mds., or 1.4 labourers per acre. An estate with an average yield of 18 mds. per acre would require 1.5 labourers + .05 labourer × 5 mds., or 1.75 labourers per acre.

Where sectional areas are to be compared, .3 of a labourer is deducted, irrespective of yield, account fixed charges, *i.e.* account overhead costs and the cost of labour employed on the estate, but not directly in the tea areas or on the manufacture of crop obtained from these areas. Therefore, for an area yielding 11 mds. per acre, the gross profit must be calculated on a labour requirement of 1.4 labourers per acre, less .3 labourer account, fixed charges, or 1.1 labourers per acre.

In the same way the labour requirement for a sectional area yielding 18 mds. per acre would be calculated on a labour requirement of 1.75 labourers, minus .3 account, fixed charges, or 1.45 labourers per acre. Thus the extra crop will require .35 labourer more to handle.

The following comparison is made on the basis that a labourer costs Rs. 650.00 per annum, the cost of fuel, tea chests, selling costs, tea cess, road tax etc. is Rs. 40.00 per acre and the cost of fertilisers is Rs. 125.00 per acre. The average realisation of the tea is taken as Rs. 2.00 per lb.

	At 18 mds. per acre	*At 11 mds. per acre*
Realisation on sale of tea ..	*Rs.* 2,880.00	*Rs.* 1,760.00
Labour ..	942.50	715.00
Fertilisers	125.00	125.00
Fuel, packing, transport ..	720.00	440.00
Gross profit	1,092.50	480.00
Less fixed charges ..	480.00	480.00
Net profit per acre..	612.50	Nil

The profit difference is thus Rs. 612.50 in favour of the greater crop.

Overhead irrigation of bananas in the Transvaal Photo: Aluminium Co. of S. Africa Ltd.

The fact that no net profit for the smaller crop is shown does not mean that it has not paid to retain the area in bearing. A profit on the working of an area and the crop produced from it must increase the profit on the whole area by a like amount. The balance, however, indicates that the yield of 11 mds. per acre area did not carry more than the average cost per acre of fixed charges and overheads.

In this comparison, it would probably be better to say that the gross profit in the case of the 18 mds. per acre section was Rs. 1,092.50, against only Rs. 480.00 in the case of the 11 mds. per acre section.

The cost of applying water has not yet been ascertained with any degree of accuracy, as the installation has not been properly completed, but the indications are that the cost of precipitating rain equivalent to 6 in.–8 in. during the dry season will be between Rs. 40.00 and Rs. 50.00 per acre.

It is not to be implied that the mere application of water will, in the first year, increase the yield of mature tea from 11 to 18 mds. per acre. But, should the first year of irrigation happen to be a drought year, irrigation is likely to prevent a drop in yield of, say, 4 mds. per acre. The good effects of irrigating are cumulative, particularly in so far as mature, previously unirrigated tea is concerned.

Conclusion

The extent to which young tea suffers a setback, as a result of drought, is made abundantly clear when a young area is irrigated and a comparable area is not. There can, however, be no doubt that in districts such as the Nowgong district of Assam irrigation and the application of fertilisers will, together, quickly bring about an increase in yield of at least 4 mds. per acre above what would be the yield of the same section without irrigation, and more if the area has been irrigated from the time of planting and annually during the dry season in subsequent years. In short, tea irrigated from the time of planting will, with adequate nitrogen, give the best yields it is possible to obtain in a district subject to drought.

† 1 maund = 80 lb.

Water Use Methods Need Revision

ADDRESSING a symposium on 'Water in Agriculture', held in Sydney by the Australian Institute of Agricultural Science and the Men of the Land Society, **Mr. A. G. Lowndes** said that the relative economy of spray and flood irrigation was a vital subject.

'Very little investigational work seems to have been done on it in Australia', he said. 'My experience and observations suggest that spray irrigation is probably four times more efficient in water use than flood irrigation'. Otherwise expressed, it is possible to get four times more production from a given volume of water by using spray irrigation. If this is so, the policy for the utilisation of irrigation water needs complete revision.

Yet Government departments are planning to spend large sums of money on the development of irrigation areas working almost exclusively on the continued use of flood irrigation, the least efficient method of using water.

Other speakers, however, spoke in defence of flood irrigation and discussion was keen on the relative merits of the two systems in different circumstances.

Mr. E. R. Hoare (*officer-in-charge of the C.S.I.R.O. Research Station, Murrumbidgee Irrigation Area*)

On the more impermeable soils the value of spray irrigation was limited, as the water would not move freely through the soil, and spray pipe spacings had to be reduced and this increased the cost of equipment.

Speakers in favour of spray irrigation claimed that it was less wasteful of water and gave plants water when most needed. Further, the water was applied under control, which meant no drainage problems, such as are often met in flood irrigation.

Outlining what happened to water in the soil, and how the plant's ability to get water supplies varied in differing conditions of soil and soil moisture, **Dr. N. Collis-George** (*Associate Professor of Soil Science, University of Sydney*) said that knowledge of the behaviour of different soils could be a valuable guide in irrigation practice.

It was just a question of keeping enough water in the soil to allow the plant adequate supplies, but not too much. Farmers should use soil moisture measuring devices to guide them.

Mr. L. F. Myers (*officer-in-charge of the C.S.I.R.O. Regional Pastoral Laboratory, N.S.W.*)

Before expecting increased production from irrigation it was essential to see that the plants had sufficient nutrients.

In the Riverina most plants, even saltbush, responded to dressings of nitrogen, and many cereal yields could be markedly increased by top-dressing without any additional water.

'Efficient water use begins when soil fertility is high and agricultural practices attain high levels', he said.

In irrigation trials at Deniliquin it was estimated that summer irrigated crops often produced less than a ton of dry matter per acre foot of water used, whereas winter pastures, irrigated autumn and spring, produced three to four tons per acre foot.

Other research results raised the issue whether to irrigate fewer acres with more water or more acres with less water.

In opening the symposium, **Sir William McKell** (*President of the Men of the Land Society*) criticised the tendency of many primary producers to lose interest in water conservation when the drought period passed.

Outlining problems of water use in the U.S.A., **Dr. Harold Wanless** (*Professor of Geology, University of Illinois*) said that the siltation problem was being thoroughly investigated there. However, it was feared that some of the costly reservoirs would be completely silted up before they had been paid for.

American farmers were being encouraged to use extensive soil conservation measures to protect the big irrigation schemes from silting up.

Mr. A. F. Burne (*acting senior engineer N.S.W. Water Conservation and Irrigation Commission*) emphasised the need for regulation of the use of rivers for private irrigation schemes. The authorities had an enormous problem in dry periods when they were inundated with requests for permits from landholders who wanted to begin pumping from watercourses. *Abstracted from 'The Australian Producer'.*

Money from Muck

JAMES M. FERRIS*

' I venture to predict that the people of this country will soon . . . identify the well-washed contents of their closets with rounds of beef, saddles of mutton and rich milk. The ladies will recognise in every slop that leaves the house a richer, cheaper and more abundant supply of that element—milk, which is to develop in their offspring, by bone and muscle, beauty and power, mental and physical '.

J. J. Mechi (100 years ago)

MECHI, an Essex farmer, was a great advocate of good farm 'management, indefatigable in his efforts by precept and practice to improve the farming methods of his day. He was also one of the pioneers of power farming and proved that the 'mighty power of steam' could make farming not only more easy, but more profitable, and that nearly a hundred years before power farming really came to Britain. His two steam engines cost him £500 – a lot of money in those days when a plough could be bought for £5 and Britain was on the gold standard.

The Mechi system

His most revolutionary practice – not yet adopted in Britain – was his system of collecting in a central cess-pit by means of a comprehensive drainage system all the excreta from his farm (animal and human, solids and liquid) and using the mixture as liquid fertiliser.

> ' By directing a jet of water, as powerful as from a fire-engine, into the solid pudding (of cow dung), it flows from every shed in a lazy stream through a subterranean pipe to a great tank, whence, when further diluted, it is propelled to the fields. It is hardly possible to appreciate the advantages of the irresistible and all-powerful jet; in five minutes it covers your buildings and yards with a torrent of rain. It is of a thousand scrubbing-brush power, cleansing every crack and cranny, washing away rats, mice, flies and smells and leaving at all times, but particularly in hot weather, a most refreshing sense of cleanliness. Excessively fat pigs and other animals luxuriate in this shower-bath after recovering from their first alarm '.

By the time the material reached the cess-pit it was well mixed with water and in a fluid condition. Then after the addition of water it was pumped through a system of pipes, hoses being attached at convenient points for the actual spreading. The permanent pipes were laid underground and were made of iron; the flexible pipes he used were made of Gutta Percha (before the age of aluminium, plastics and rubber—*Ed.*).

Mechi housed his animals on slatted floors. He regarded this as an indispensable part of his system for the ease it gave in washing down. Into his cess-pit, too, he threw all his refuse; he states that on one occasion he had no less than between 20 and 30 dead cows and horses in his pit. Nothing was wasted, he states, for:

> ' the light of science has dispelled the darkness of our ignorance of these subjects. We know by our great chemists that our sewers contain the elements of our food – of, in fact, our very selves – and that to waste them, as we do now, is a cruel robbery on the welfare and happiness of our people '.

That, then, was his sanitation system. It was both simple and effective. Even so, it was only an adjunct to his irrigation system, for there is no doubt that to Mechi, and to a very small handful of his contemporaries, must go the credit of being the very first to irrigate by artificial rain. He was certainly the first to irrigate by power through pump and pipeline.

He concluded: ' Practical experience has taught me that this sewage is all the better for ample dilution; the more you flood your cities with limpid streams, washing away from every tainted and poverty-stricken court and alley the elements of pestilence and suffering, the more the grateful earth will absorb them in her bosom, returning them to you as treasures of health and strength'.

Sewage disposal today

In 1959 the aim and object of every sewage purification works is to separate the liquid from the solids so that the water can be discharged as ' pure '

Receipt . . .
' Sock ' arriving at the cess-pit. ' Sock ' is the mixture of excreta and urine which has been broken down and diluted with wash water in the stables

. . . and delivery
Here is a Farrow model 50 rain-gun spreading the ' sock ' over a pasture. This gun is equally useful for plain water irrigation

* Farrow & Sons Ltd.

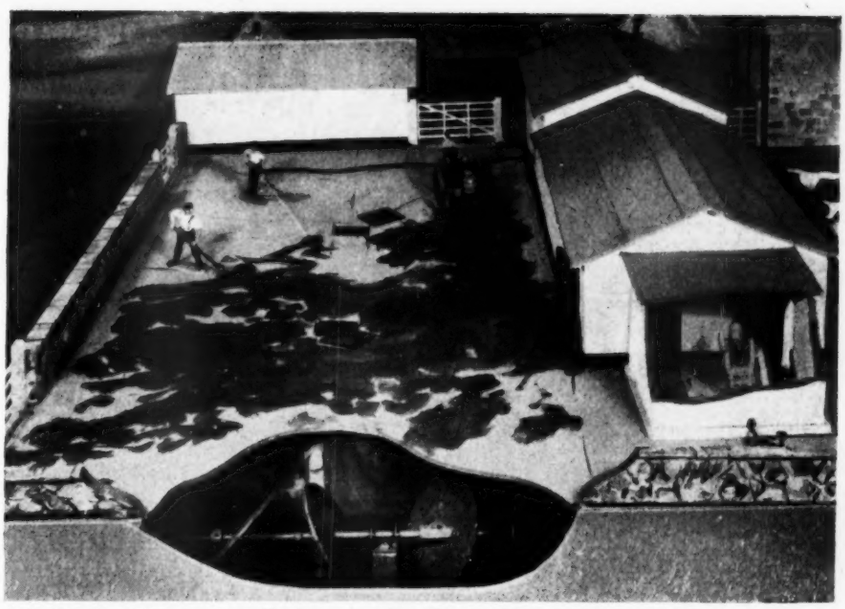
into some stream. Unfortunately, it seems that this can only be done by dissipating through controlled bacterial activity the nitrogen content of the sewage, so that of the two end-products the water may be 'pure', but the other, the sludge, is a relatively valueless commodity.

This prodigal destruction of nutrient riches is highly defensible on grounds of hygiene, yet it remains prodigal, and in the hundred years since Mechi first wrote those words its effect on the food-producing countries of the world is becoming only too apparent in the soil exhaustion of the older plantations. In many parts of the world today there is a crying need for fertilisers, which, for many reasons, are unobtainable. In these circumstances organic manures – and by organic manures is to be understood the excreta of man and beast – remain to them the chief and very real source of replenishment. Indeed, whatever views one may hold on the relative merits of artificial versus organic manures, the inalienable fact remains that the value of organic manures becomes the greater when 'artificials' are expensive or, worse still, unobtainable.

In an attempt to overcome the serious position, bigger and bigger irrigation projects are being put in hand, and more and more virgin land is being brought under cultivation to have, in turn, its nutrient riches destroyed in the sewage works of the big cities of the world. This profligacy with the earth's riches devolves on the shoulders of those least able to bear it. In many parts of the tropics people are now face to face with the problem of cumulative soil exhaustion. The use of excreta as a soil nutrient offers an immediate and practical answer.

The application of organic irrigation would seem to be the only immediate practical answer where there has been a continuous denudation of their soils by cropping. The secret of success lies (as Dr. Brünner has pointed out) in the speeding up of the fertiliser circle, so that the same nutrients do their job two or three times a year; it is equivalent to really large applications of artificials. The great advantage of the system, moreover, is that these results are obtained by means of a capital cost on which depreciation is low rather than by an annual expenditure on consumable chemicals.

One real difficulty is that in those parts of the world where it could do most good there is little animal husbandry. It seems, therefore, that in the absence of animal excreta, human excreta must be used. In principle the system would be identical, the only difference being in the method of collection. There might be some difficulty in persuading the medical officer to agree, but the institution of water-borne sanitation at all would be a great advance over many of the present practices in some tropical plantations.



Model of a Farrow installation, showing the washing-down operations, a cut-away section of the cess-pit, the pumphouse and, on the extreme left, the rain-gun

Mechanical equipment

Mechi's systems almost seem to have died with him and for the continuation of the story the scene has to be shifted to the Alps, where over the past 50 years very arduously and very slowly they are working back towards the same conclusions. Only in the very recent few years are they beginning to accept some of the things that Mechi regarded as essential.

What, of course, the Swiss have been able to do is to improve the equipment. Electricity or diesel fuel has ousted steam; asbestos cement pipes, being cheaper, are now more commonly used than iron for the permanent systems and lightweight metal pipes with rain-guns or hand-operated throwers have replaced the gutta percha pipes and simple nozzles. Mechi's cess-pit was circular; he found agitation was absolutely necessary and he did it by compressed air. The Continentals have found agitation equally necessary, but because they have leant towards mechanical agitation they make their tanks long and narrow.

Mechanical agitators suffer very little wear and tear and are certainly not delicate things like air compressors and their power requirement for the same job is less. As for the pumps, there has not been any great improvement. Mechi used piston pumps and so do the Continentals. Centrifugal pumps are not very suitable for dealing with this sort of liquid, since the design of the pump has to be so modified that its efficiency at normal irrigation pressures falls to a level that is economically doubtful. Furthermore, the liquid is liable to gasify if it is stored even for a short time, a circumstance which again makes centrifugals not ideal. Thus piston pumps are still probably best for such work.

The expense of an organic irrigation scheme is little more than the expense of a similar plain water irrigation scheme, and if enough water is available it can do both jobs, so that it is a sound proposition. Some additional expense is incurred partly in the cost of the agitator and partly in the higher price of the piston pump over the more usual centrifugal. Also, there is the cost of building the drains and cess-pit.

Although pump and pipeline are the obvious method for spreading diluted sewage, it could also be done by water-cart, but here the material has to be carried as a concentrate.

This is not a good alternative, because the use of undiluted sewage can be dangerous to plant life. Dr. Gisiger, of the Institute for Agricultural Chemistry at Berne, has shown that pumping is some 30% cheaper than carting. Even so, this latter method is popular in Holland and Denmark.

There are many towns today that dispose of *digested* sludge on agrarian land using modified forms of overhead irrigation equipment, but processed sludge of this sort has little agricultural value.

There is only one town in Britain from which *untreated* effluent or 'sock' is spread on agricultural land, and that is Dudley in Worcestershire. The ' sock ', which is free of solids above colloidal size and looks rather like well-stewed tea, is pumped through pipes to the highest point of a group of farms, from where it flows again through pipes on a weekly roster to each individual farm in the scheme. The actual spreading is done by gravity as surface irrigation.

Ample dilution essential

There are, of course, certain obvious precautions to be taken. The possible contamination of drinking water supplies would have to be avoided.

It might also be desirable not to irrigate tea with ' sock ' within one month of plucking, but there is not much risk providing plenty of water is used, since any disease bacteria will either be washed off by the tropical rains or destroyed by the sun.

Fortunately, also, disease germs appear to succumb in contact with soil organisms, and because most soils are good mechanical filters spreading the material over agricultural land is probably the best way to dispose of sewage, even in the more highly industrialised countries of the West.

The importance of high dilution is not confined to the medical aspects. It is an essential part of the system. Water is the cleansing agent washing away the ' rats and flies ' and all ' the elements of pestilence and suffering '; it becomes the supreme conserving agent for nitrogen as ammonia; it becomes a cheap and very efficient vehicle for transporting the muck out to the field; and, finally, it has a vital role to play in the life of the plant. In this connection it must also be pointed out that insufficient dilution can do harm, for the spreading of strong undiluted manure can be lethal to some plant life.

It is in the conservation of excreta that water plays a unique part that has been almost universally unrecognised and, indeed, tacitly denied. Mechi recognised it and leading opinion on the Continent is just beginning to recognise it, but elsewhere it has just not been accepted. On the contrary, wherever liquid manure is collected elaborate arrangements are usually made to keep water out.

The point, however, is this. According to Schöllhorn,[3] the undigested protein residues in the dung and the uric and hippuric acids of the urine are very rapidly broken down by ferments into ammonium compounds, chiefly ammonium carbonate, which is a very unstable compound very readily breaking down to ammonia and carbon dioxide. Both are gases and so are difficult to hold. But water will dissolve them both, and the more the water the more certain their retention. What is more, fermentation, being an oxidation process, is a heating process. Large quantities of cold water will therefore slow it down. Water is thus the ideal means of conserving excreta nitrogen, a will-o'-the-wisp so fugitive that, believing its escape inevitable, many authorities write muck off as practically useless.

Conclusion

Dr. Giovanni Friedmann,[4] a very revered figure on Continental agriculture, wrote in 1938: ' We must succeed in making those that govern us realise that the (European) nations have living room enough and exuberantly to spare for many, many years to come . . . and at this very moment, in spite of the fact that much is covered with heath and sedge, that the area is greatly reduced by salt marshes and mud flats, high mountains, deep ravines, that much is sterile, much rocky, much inhospitable, that bracken and bramble are stealing away more and more of it every year, in spite of all this, the fact yet remains that it would be possible to sustain in and out of the lands of Europe (by means of an agrarian policy based on organic irrigation) a population infinitely more dense than it is at present and, what is more, to sustain it in the riches of abundance and in the radiance of health '.

If this vision is true for Europe, then it is true for anywhere else in the world, particularly in the leached out and exhausted soils of the tropics.

The cess-pit filled with the ' sock '. The agitator is fitted with oblique-set paddles and is driven by a ' Rotor ' gear powered by a 3-h.p. motor. The special Farrow, model 120, double-acting sludge pump sucks up and delivers the ' sock ' to the rain-gun in the meadow at 80 gal. per hour at 80 lb. pressure

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Better Water Management

Not too Much or too Little

High yields of agricultural and horticultural crops can generally be obtained if water is applied at the right time and in the required amount. Too much water can be as harmful as too little.

Photo: T. W. Prosser & Co. U.S.A.

The ' Irrometer ' indicates the soil-moisture condition on a dial; the readings can be read and plotted on a graph at regular time intervals

THE measurement and control of soil water in an irrigation system has been assisted by the adoption of soil suction rather than water content as the measured variable. Tensiometers, which have long been used in research because of their accuracy and sensitivity, indicate soil suction directly as a reading on a dial.

Energy of abstraction

The readings automatically compensate for variations in type of soil, contour, rainfall and temperature, because the instrument does not measure percentage of moisture, but registers instead the energy necessary to detach water from the soil particles. Thus, if the soil is saturated, no measurable energy is required for the roots to break moisture away from the soil and the reading is zero. After surplus water has drained out of the soil by gravity the soil is at field capacity, and so a small amount of energy is required to abstract the water from the soil. This force is represented by readings in the 10–20 range. As the soil dries out, more suction has to be exerted by the roots of a plant to obtain its moisture, and this is represented by successively higher readings. A reading of about 75 indicates that the available moisture is getting near the wilting point and is dangerously low for minimum growth.

The type of soil used makes no appreciable difference. For instance, plants growing in either a clay or a sandy soil, if the gauge in both cases reads 40, are exerting the same energy in order to draw moisture from the soil. Clay soils, of course, store much greater amounts of water than sandy soils, but growers do not have to be concerned about this; it only means that the soil moisture lasts longer, and this is reflected in a proportionately slower rise in the gauge readings.

In hot weather, when more moisture is used by plants, the rate of increase in the gauge readings is directly proportional to the rate of plant use of water in that type of soil. When the soil is moistened, due to rainfall or irrigation, this is reflected as a drop in the gauge reading, the extent and sharpness of the drop being dependent on the amount of water applied and the permeability of the soil.

In effect, this instrument evaluates the water-holding capacity of the soil: the rate of plant use of soil moisture and the effect of added water, just as the petrol gauge on a car shows the size of the tank, the petrol consumption and the intake of petrol. The motorist keeps a safe reserve of fuel in his tank, and the grower, too, should keep a safe reserve of moisture in the soil. Just as the amount of the motorist's reserve will depend upon the size of the tank, the petrol consumption per mile and the distance between filling stations, so also will the amount of reserve moisture allowed by the grower depend upon the water - holding capacity of the soil, the seasonal rate of plant use of soil moisture and the availability of water and labour, when irrigations are needed. The necessity for maintaining this reserve is the only reason for irrigating different soils at different gauge readings; the amount will depend upon individual conditions and can best be determined by the grower.

Siting of stations

The number of instruments required for an installation varies widely with the crop being grown and with local conditions. Irrigation control is based on 'stations' with one or two instruments, which establish a 'zone of moisture control ' dependant upon the depth of the active root zone, for the depth of the root system determines the depth, or depths, at which instruments should be installed at each station. Under the most favourable conditions

– level land, uniform soil and large irrigation blocks—one station may be adequate to cover many acres; under less favourable conditions up to one station per acre may be required.

To obtain the full benefit of control the stations should be correctly sited and the most important consideration is probably variation in soil type. A station located in each different soil type makes it possible, through timing and duration of irrigation, to maintain more or less the same amount of available moisture in all areas.

Placement of instruments

In furrow irrigation the ceramic tip which is the recording portion of the instrument is normally placed on the inside edge of the inside furrow. In tree crops the instruments are generally placed on that side of the tree which receives the afternoon sun. In row crops they would normally be placed in the row. Since lateral movement of water varies widely with different soils, the closer the tip is located to the side of the furrow, the more representative the results will be.

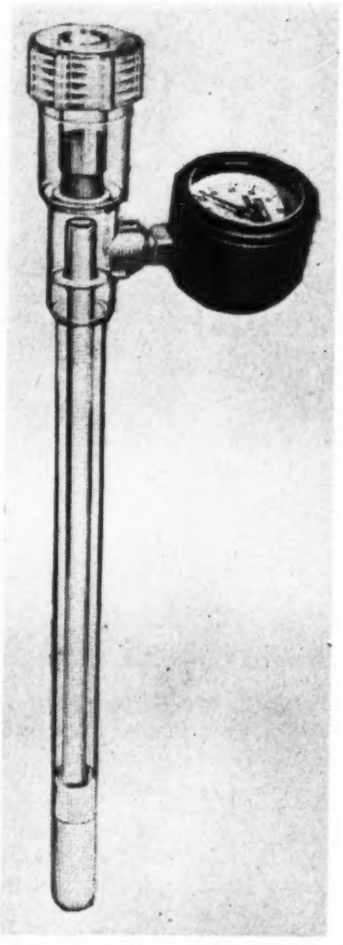
In flood or border irrigation, instruments are normally placed approximately two-thirds of the way down the run, as this generally is the point most critical for adequate penetration. As a general rule it is best to locate the instruments at the drip of the tree in tree crops or actually in the row in row crops. It is also desirable to use instruments 6 in. longer than desired for placement, so that the gauges can be set higher above the water level when irrigating. In some cases it has proved beneficial to place instruments on the border itself, at an angle, so that the tips are located in the root zone of field crops.

With sprinkler irrigation instruments are normally placed on the side of the tree where the afternoon sun shines and at the drip line of the tree. It is necessary with tree crops to ensure that branches and heavy foliage do not obstruct sprinkler water distribution near the instrument and that they are not located beyond the pattern range of the sprinkler.

Number per station

For very shallow-rooted crops with root systems of up to 18 in. one instrument per station is enough; when the plant is young the instrument is set only a few inches deep; as the root system extends the instrument should be set at greater depths until maximum root growth is attained.

The use of two instruments per station is recommended for crops with root systems 18 in. to 84 in. deep. The 'shallow' instrument is placed with the ceramic tip at about a quarter and the 'deep' instrument at about three-quarters of the depth of the root zone. When the soil moisture is known at these depths an accurate estimate can be made of moisture conditions throughout the root zone. As approximately 90% of the moisture requirements of the plant are obtained from the upper three-quarters of the root zone, a two-instrument station makes it possible to maintain the desired moisture condition in this upper region, while conserving water and fertiliser by preventing over-irrigation.



The instrument has a leak-proof, porous ceramic tip and an hermetically-sealed neoprene cover. They are available in six lengths, ranging from 6 in. to 48 in.

For many years tensiometers have been used by research workers. With the tremendous growth of irrigation in recent years, growers, too, have felt the need for a reliable and simple instrument for the measurement and control of soil moisture. Thousands of tensiometers are now used in the U.S.A., particularly in the western states of California and Arizona, where citrus and avocadoes may often require year-round irrigation; in other parts of the world, too, growers are appreciating the value of the tensiometer as an instrument for ensuring the effective use of labour and irrigation equipment and the most economical use of that most important national resource—water.

Cross-pollination

Commercial growers of food crops like to be able to rely on every plant that they are growing to produce the special characters of the variety of their choice. Trueness to type and variety can only be maintained if the crops, which are being specially grown for seed, are protected from pollination by other 'cultivars'.* Pollen may be carried by insects or by the wind from one crop to another for distances of a mile or more and seed growers make every effort to avoid cross-pollination of their seed crops by isolating them from others which could prove harmful. Their careful work will be wasted if even one or two plants in some private garden or allotment within a mile of the seed crop are allowed to flower so that their pollen reaches the crop being grown for seed.

This danger of cross-pollination is most pronounced in the cabbage family, because they are usually over-wintered and may flower before the ground is cleared. The brassicas include cabbages, savoys, brussels sprouts, cauliflowers, heading and sprouting broccoli, and the various types of kale; beetroot and other vegetables can also run to seed if not used in time. It is necessary, therefore, to destroy all plants of brassicas and root crops before they flower and thus help to maintain the purity of the seed which they will themselves be sowing in future years.

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* Cultivar: variety of strain.

Water for Irrigation

The Need for a Systematic Survey

DOUGLAS WOOD, A.R.S.M., F.G.S., A.M.INST.PET.

Water for irrigation is derived from surface or from underground sources. In the former are included lakes, rivers and artificial reservoirs created by impounding the flow of rivers by dams.

WATER sources may be distant from the land it is desired to irrigate and arrangements must be made to pipe or canalise the water. The alternative system of constructing tube wells on land destined for crops and bringing this water to the surface has many advantages.

An irrigation project, based on either system, should be preceded by a survey, the purpose of which is to ensure, so far as may be possible, that the project is sound and will have a successful outcome. Such a survey will include the compilation and study of relevant data and, where the available information is inadequate, the making of tests for the appraisal of factors of importance in the development of the scheme.

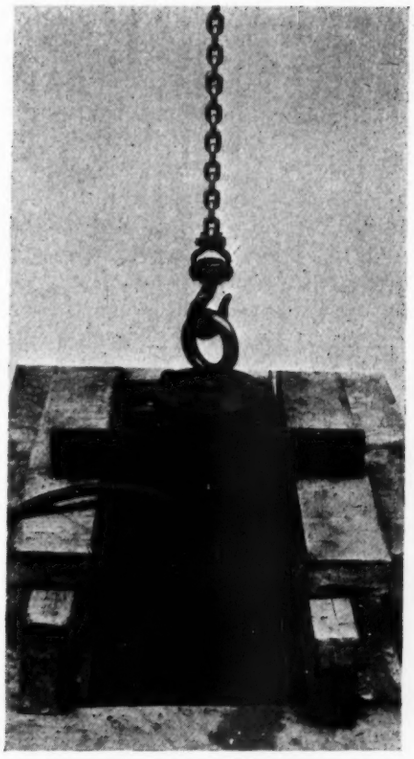
The survey

The following is a generalised prècis of what is required before a tube well project or a system of canalised irrigation is planned.

Geography. It is essential to know that the selected area is one susceptible to development by such a scheme. Distribution of the water is obviously facilitated by a level or nearly level terrain and obviously only in special conditions can rugged, mountainous areas be considered for irrigation. Geography will control the suitability of the selected area in relationship to populations, and the distribution and marketing facilities for the crops to be grown. An aerial survey may be helpful and the means of saving of much time.

Geology. Studies of the geological formations, their nature and disposition are necessary to assess the likelihood of underground water-bearing strata, and to determine the depths at which water may be encountered. Geological studies are also necessary to determine the characters of the foundation rock where it is proposed to construct a dam and reservoir with its ancillary canal systems.

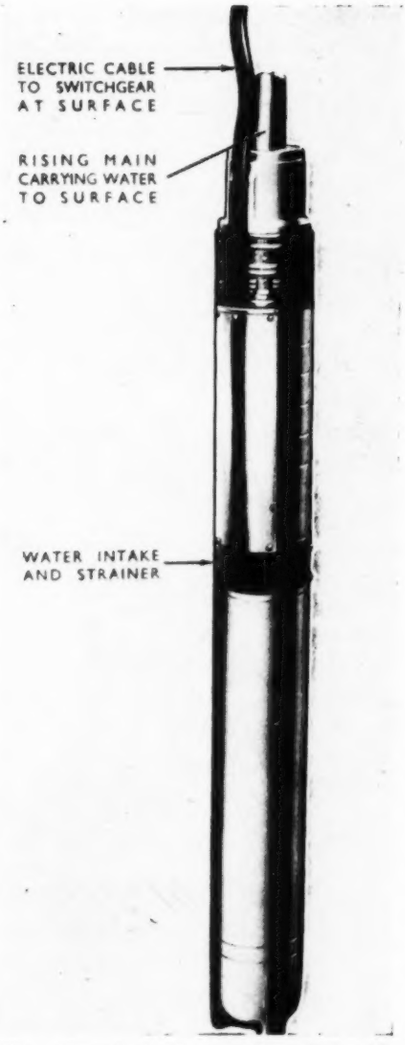
Hydrology. Climate will determine precipitation in the catchment area supplying surface or underground reservoirs. For appraisal of the latter it is essential to understand the weather, rainfall, transpiration, run-off, evaporation and other factors which will control the effective recharge of the aquifers to be tapped by tube wells.



A deep-well submersible pump being lowered into a borehole

Ground Water Survey. For the development of a sub-surface water supply, geological and hydrological data must be combined with calculations of permissible rates of withdrawal of water, with chemical analyses of water and all other factors governing the feasibility and continuing efficiency of a tube well scheme. Data on existing wells, drilling and pumping conditions and on the sub-surface flow of water should be recorded and analysed. Test drilling may be necessary to obtain geological and hydrological data where the available information is scanty.

Soil Analyses. The nature of the soil



The Beresford deep-well submersible pump will deliver from 400 to 600 gal. per hour, according to the depth of well

and its reaction to water from the proposed source should be studied. The physical and chemical characteristics of the soil need to be determined.

Agronomy. Economic crops suited to the soil and climate have to be selected. The correct agricultural technique for their growth and maximum productivity, and for the maintenance of the soil in adequate fertility should be proposed.

Irrigation and Drainage. Detailed contouring of the land will be essential before any reticulation scheme for the distribution of water can be begun and equally important will be attention to effective drainage. Tube wells can sometimes be sited on slight eminences, which will facilitate irrigation by providing a natural gravity flow.

Civil Engineering. Much of the project itself is in the category of civil engineering, but there may be other factors which will have an important bearing on the undertaking and their existence or absence should be known and recorded. Such are roads, railways, availability of power and water, workshop facilities and the like.

To these should be added information on many other matters, such as living accommodation, local wages, availability of labour, of transport and the types most suited to the area and their fuel and food etc.; in fact, as the constructional work may be placed in the hands of foreign contractors, it is desirable that the survey and report should include any information which may assist the smooth progress and rapid completion of the undertaking.

Costing. Of great value, even with many 'unknowns', is some sort of estimate of the probable costs of various phases of the project. Previous experience will often permit the consultant to hazard a series of rough figures which at a later stage can be replaced by accurate estimates or tenders. This preliminary estimate of the cost and of the time involved in implementing the project is required for a correct evaluation of its probable economic benefits.

Economic Benefits. Values for the crops to be grown should be assumed and a calculation made of the time necessary for the crop revenue to repay the capital investment and operating and maintenance expenses. These considerations of money and time can be reinforced by a number of less tangible benefits which may often outweigh in importance the immediate financial benefits. Such are the settlement of barren areas, independence of food imports, increase of health and population etc.

Method of investigation

There can be divided opinions on the proper order of undertaking the various surveys which should precede an irrigation project. For example, should studies of the fertility of the soil precede a ground water survey? It is obvious that unpromising results from either would cancel the need for the other.

Should both of these be preceded by an assessment of the social and economic needs and possible markets for the surplus crops? Clearly the justification for the project will depend upon these factors, but consideration of them is useless if water cannot be made available.

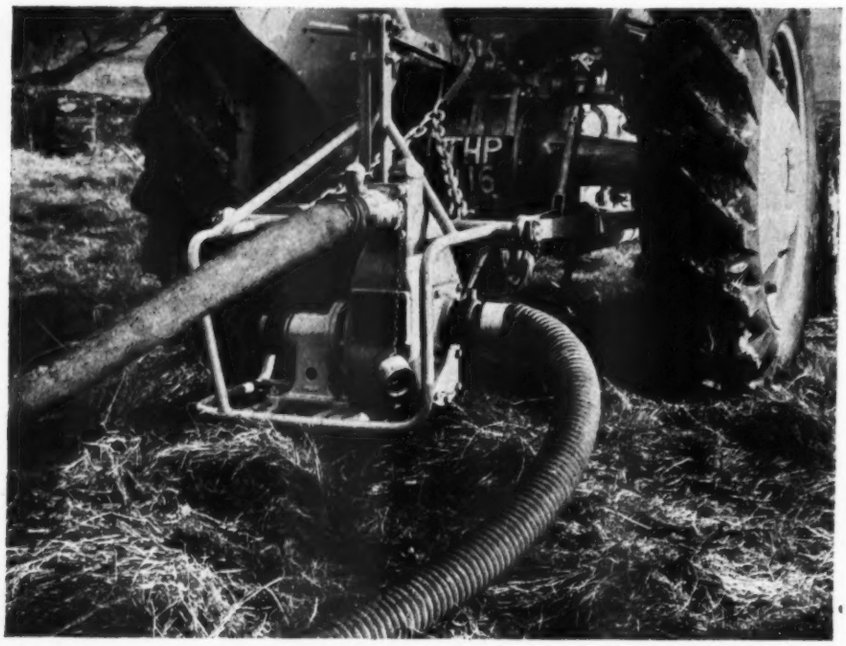
Should budgetary figures for cost and time be roughly estimated in the first place and evaluated in relation to the probable income from the crops to be produced and the indirect results of the project's impact on the well-being of a section of the population, or on the settlement of a hitherto undeveloped area?

Need for consultation

If the costs are likely to be beyond the means of the authority concerned or to exceed any available finance, the rest of the survey will be wasted. The figures needed for such an estimate, however, cannot be produced until much of the survey has been carried out. Consultants with experience in this field should be able to give a preliminary idea of whether the scheme is likely to prove economically a success or a failure. Where assumptions are untrustworthy and the prospect is to some extent uncertain, or is a borderline case, considerations less tangible than the construction of a hypothetical profit and loss account will decide the issue.

Importance of test boring

Where tube well projects are proposed – and their merits should always be considered, even where the construction of a dam and reservoir appears to be the obvious solution – it cannot be stressed sufficiently that, if no tube wells are in existence, the drilling of a test hole or holes is more important than all the rest of the survey: without the assurance of adequate sub-surface water which only a test hole can give, the results of a project are a matter of chance. Dependable results from a test hole are only obtainable if the design and method of drilling the hole are properly planned.



The 'Watermaster' tractor-mounted pump will raise water from a depth of 25 ft. and deliver up to 16,500 gal. per hour

The Cultivation of Citrus

2—Irrigation and Drainage

PROF. H. D. CHAPMAN*

Moisture management in orchard soils is exceedingly important. Though it revolves around the prevention of moisture deficiency, or stresses, and the control of moisture excess, the achievement of both of these ends under the infinite variety of soil conditions, where citrus is grown, is not simple.

Furrow irrigation of citrus. From four to six furrows between rows are usual for mature citrus and the optimum length of run is about 300 ft.

THREE methods are in common use for applying water to orchards: furrow, basin and sprinkler. Each has certain advantages and disadvantages and final choice is often governed by a variety of factors, such as soil type, amount of water available and topography.

Irrigation systems

The *basin system* is best adapted to reasonably level soils and is often used on soils where permeability is so rapid (*e.g.* sands) that the furrow system cannot be used. A large head of water is transported rapidly via a single furrow to successive basins around the trees. The *furrow system* can be adapted to nearly all kinds of terrain, but, like the basin system, is easier to handle on more level soils. Conversely, the *sprinkler system* is better adapted to uneven, broken or hilly land where levelling is too costly or is impracticable for other reasons.

Despite the initial levelling and installation cost, the furrow system has some cost of operation and other advantages. In addition to the usually greater labour cost involved in portable sprinkler systems, there is a tendency to apply too little water per irrigation to effect deep penetration. This tends not only to limit root penetration, but, even more serious, will often lead to salt accumulations in the root zone in dry climates. Both of these are aggravated by the tendency for many soils to seal over under the impact of the water drops, causing excessive run-off. In addition, micro-relief variations result in local run-off and pooling, which makes for uneven water penetration.

In addition, with waters that contain over 500–700 p.p.m. soluble salts there may be sufficient salt absorption by citrus foliage to cause damage. There is also some danger with citrus of promoting brown rot gummosis of the trunks owing to excessive water reaching the soil adjacent to tree trunks. With the growing tendency to distribute soluble fertilisers via irrigation water, there are advantages in the furrow and basin systems over the sprinkler system.

Disadvantages of the furrow system are the tendency for salts to accumulate in furrow crests and uneven water distribution. The salt accumulation problem is somewhat serious where the salt content of the irrigation supply is high and where rainfall is limited, or seasonal, in character. Often the salt in the furrow crests which accumulates during the non - rainfall irrigation season is carried into the root zone by the first seasonal rain and causes root and tree damage.

The second disadvantage of furrow irrigation, *viz.* the tendency for the furrow ends to be slighted on water, can be partially overcome by using short runs. On many soils the run should be no longer than 300 ft. Water should be applied long enough to assure deep or adequate penetration at the furrow ends. This means that some wastage of water by excessive percolation will result at the furrow heads; there will also be some loss of fertiliser by leaching and some soil erosion.

There is a current interest in deep mulching of citrus groves with wood shavings or other organic materials, and under these conditions the only practical way to irrigate is by the sprinkler system.

A change over from the furrow to the sprinkler system should be done only after consideration of all the factors involved: salt content of the water, labour requirements of the sprinkler versus the furrow method of fertiliser application, slope, soil type, profile characteristics and erosion characteristics of the soil.

Amounts and frequency of irrigation

No specific directions can be given, as climate, soil texture, depth of soil, drainage characteristics, salt content of water and water availability, as to both amount and timing, all have to be considered. Therefore, only guiding principles can be mentioned.

The first is that a certain amount of water must be wasted by deep percolation beyond the root zone. It is not requisite that each irrigation be excessive, but in the course of the irrigation season, sufficient irrigation water and/or rainfall must have penetrated the soil to keep salts flushed out. Heavier than usual irrigations are best carried out during summer months, when the need for deep penetration and water availability is greatest and also to minimise any

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tendency for over-moist subsoil to persist for long periods.

As the salt content of an irrigation water increases the amount of water to be wasted by deep percolation must increase. Various formulae (Eaton, F. M., *Texas Agr. Exp. Sta.* Misc. Pub. 111) have been worked out equating salt content with wastage requirement.

Making certain simplifying assumptions: (1) that there is no salt removal by rain, (2) that there is no salt removal by the harvested crop, (3) that there is no precipitation of salts from the applied water, and (4) that there is uniform application of water, the leaching requirement in its simplest form would represent the percentage of total water applied which must pass beyond the root zone as drainage to keep salt from building up beyond a certain arbitrary value.

Suppose, for example, a water of equivalent conductivity (EC $\times$ 10^6) 4,000 is used and it is desired that the drainage water should not exceed four times this concentration, namely, -(EC $\times$ 10^6) 4,000. It is clear that one unit of such a drainage water would remove the salt equivalent of four units irrigation water, thus the drainage requirement in this case would be 25%, and the leaching requirement would be represented by the formula:

$$LR = \frac{EC_{IR}}{EC_{DR}} \times 100$$

where LR stands for leaching requirement, EC_{IR} for conductivity of the irrigation water and EC_{DR} stands for conductivity of the drainage water. Substituting the aforementioned values.

$$LR = \frac{1{,}000}{4{,}000} \times 100 = 25\%$$

If it is permissible for the drainage water to have a conductivity (EC $\times$ 10^6) of 8,000, then the drainage requirement (by the above formula) for a EC $\times$ 10^6 of 1,000 water should be 12.5%, and so on.

It is obvious that leaching requirement, as determined by this formula represents a maximum figure, for it ignores crop removal, precipitation of salts and rainfall, all of which serve to decrease the salt build-up factor. Where only fruit or grain is removed from a soil, where rainfall is negligible, and with waters of low bicarbonate proportion, this formula would come closer to indicating actual leaching requirement than where the entire crop is removed, as in the case of forage for hay, or where rainfall is substantial, or where bicarbonate and sulphate precipitation would decrease soluble salt in the soil solution.

The extent to which a soil should be allowed to dry between irrigations will vary with the soils and with water quality. If the soil is rather poorly drained – that is, if water moves very slowly through the soil and thus saturated or nearly saturated conditions prevail for long periods in certain subsurface horizons, it may be desirable to adopt alternate middle irrigation in order to permit each side of the tree row to dry thoroughly between irrigations. There is sufficient cross transfer of moisture within the tree to maintain the roots in the dry soil in a live condition and to supply the entire tree.

Basin-irrigated citrus. This system is widely used in South Africa for water and soil conservation

Establishing a tensiometer station. Moisture-indicating devices will indicate when to irrigate and when to stop irrigation

As stated under the section on iron chlorosis (see Part 3), one of the consequences of over-moist sub-surface conditions is the development of iron chlorosis. Many cases of iron chlorosis have been cleared up by the alternate middle system of irrigation.

Where iron chlorosis is not a problem, or drainage is not too slow, and the irrigation water contains considerable salt, less chance of periodic moisture stresses will occur if irrigation is frequent enough to prevent periodic drying out. It has been clearly shown that saline soil conditions will produce moisture stress in plants at moisture levels above the wilting percentage. Thus, if soil conditions permit, the maintenance of ample soil moisture at all times, it is a good practice, particularly if the salinity of the irrigation water is on the high side.

The best guide to irrigation frequency and amount in any specific location will be periodic tests in the various horizons for salinity and soil moisture. In the course of a number of years, in which irrigation frequency and amount are equated against soil moisture and salinity, it will be possible to work out a satisfactory irrigation regime.

Drainage

Citrus orchards do best on well-drained soils; unfortunately, drainage is not ideal in many instances and it is with these that the problem of management becomes especially important.

Although the presence of a free water table within reach of tree roots represents a hazard, it is not impossible to have productive orchards under these conditions. The chief threat to orchard health is a fluctuating water table. With a static water table, successful citrus orchards are possible even if the water table is within 2 ft. of the surface. The success of these orchards depends upon regulatory operations which keep the water table essentially static.

In some cases, despite a shifting water table, sub-surface lateral flow or other conditions are such as to keep the zone of saturation (*i.e.* the water) somewhat aerated. It is not water itself, but lack of oxygen renewal, on the one hand, and escape of carbon dioxide and perhaps other dissolved gases resulting from plant root and other biological activities, on the other, which are inimical to root health.

A portable sprinkler system in a citrus orchard. The power unit is a single-cylinder petrol engine and the water is drawn from an underground aluminium pipe carrying the main water supply. The unit develops 50 lb. pressure, operates 36 sprinkler heads and delivers 800 cu. ft. per hour

Soil aeration

The author has grown healthy citrus trees in water cultures continuously for many years where there was constant aeration of the nutrient solution (see Part 1). But where, for one reason or another, aeration is discontinued root rot and deterioration will set in in a few days. Under saturated soil conditions aeration is usually too slow to meet tree root needs and this is why a fluctuating water table too near the surface renders orchard production impossible. For the first few years of a new orchard the trees may grow well. As the roots extend into deeper layers, poor drainage or a fluctuating water table bring on root rot and once this has set in it seriously impairs tree performance.

In orchards where seasonal or permanent water tables vary between 2 and 4 ft. of the surface it is normally not possible to produce and maintain successful citrus orchards. Unfortunately, in many instances these water tables were not pre-existing, but arise as a result of irrigation. In these cases the only solution lies in drainage. If a water table can be permanently kept below 4 or 5 ft., it is usually possible to produce and maintain healthy citrus orchards.

Mounding

In areas where at the outset there is a high or fluctuating water table due to high seasonal rainfall, or to other circumstances, it is common to plant citrus and other orchard trees on the crest of ridges. This practice, called 'ridging', is utilised in Florida and other areas where rainfall and/or the water table are high. These ridges promote surface run-off and also create sufficient soil above the water table for tree roots to develop, thus avoiding the detrimental effects of an otherwise shallow water table.

In the absence of a water table, but where difficultly permeable layers occur in the soil profile, temporary periods of saturation or near saturation may occur after an irrigation or rain. Such soils present problems. The installation of tensiometers or frequent soil sampling to keep watch of soil moisture in the various horizons, coupled with irrigation frequencies co-ordinated with moisture conditions, are the best ways to handle such situations. Frequently light irrigations sufficient only to wet the surface are a means of providing moisture for the surface roots without aggravating the moisture situation below. Sometimes the use of deep-rooted cover crops will help.

(*To be continued*)

Irradiation of Stored Products

Studies on the treatment of some foodstuffs with relatively low dosages of ionizing radiations have advanced in Europe to a point where some practical applications of the method may be developed in the reasonably near future, provided that the wholesomeness of the treated food can be assured.

A report completed by FAO says, in guarded and qualified language, that impressive progress has been made in the past few years in laboratory use of radiations in extending the storage life of foods and in killing undesirable organisms in food. The report is a summary of the European meeting attended by over 200 representatives on the use of ionizing radiations for food preservation, held at the U.K. Atomic Energy Authority's Research Establishment at Harwell.

The report gives a warning that many basic problems remain to be solved before radiation treatment of foods for the extension of their storage life will be ready for widespread development and application. But it points out that a few possible applications of irradiation, such as the inactivation of *Salmonella* in egg products and of certain parasites in meat, the disinfestation of grain and certain packaged products and the suppression of sprouting in potatoes and root crops, are approaching the stage at which commercial exploitation might be considered.

Food irradiation was still in the stage of laboratory research in Europe, but plans under way in the U.S. for pilot and demonstration plants reflect confidence in the process. Present indications were that treatments involving the use of sub-sterilising doses of radiation, rather than the higher sterilising doses, were more likely to lead to practical applications in the reasonably near future. The irradiation process, the report says, performs its work without appreciably raising the temperature and thereby cooking foods, and the product need not be removed from its package.

Picking opium in a co-operative poppy farm in Bulgaria

Co-operative Farming in Bulgaria

MINCHO KYURKCHIEV

In a primarily agricultural country with no reserves of unused land the redistribution of land becomes inevitable with increasing population. Unfortunately, this does not always result in a corresponding increase in production. One method of improving agricultural output is by merging the small-holdings into collective or co-operative farms.

The harvest of tomatoes from a co-operative farm

SMALL, scattered, primitively worked and unprofitable farms once made Bulgaria one of the most backward agricultural countries in Europe. About 80% of her population were peasants who tilled the land with only the crudest tools: the wooden plough, the hoe and the scythe were the universal implements. Official statistics show that as recently as 1934 there were only 545,216 wooden ploughs and 428,833 horse- or ox-driven iron ploughs in the whole country. Over a third of the farmers had only one draught animal, or none at all; tractors and harvesters were found only on a few large farms.

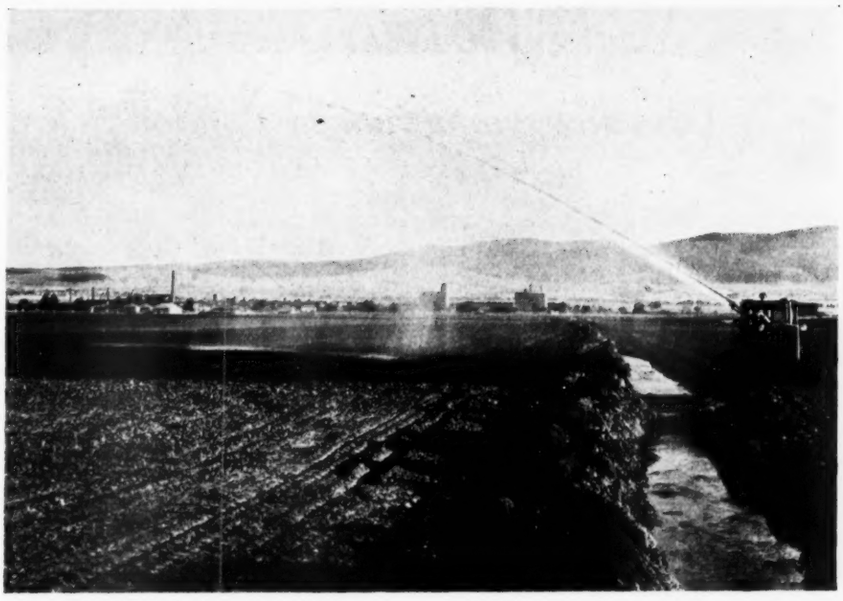
Modern agricultural techniques could not be applied because the land was divided into 12 million small plots, averaging about four decares, or one acre, in size. Over 60% of the farmers owned less than 12 acres.

In 1946 the new Government of the Republic of Bulgaria introduced reforms which limited land ownership to 200 decares (300 in the Dobrudja area) and prohibited share-cropping. Part of the land was thus appropriated by the State to form a land reserve and another part was distributed among the poor peasants and newly-formed co-operative farms.

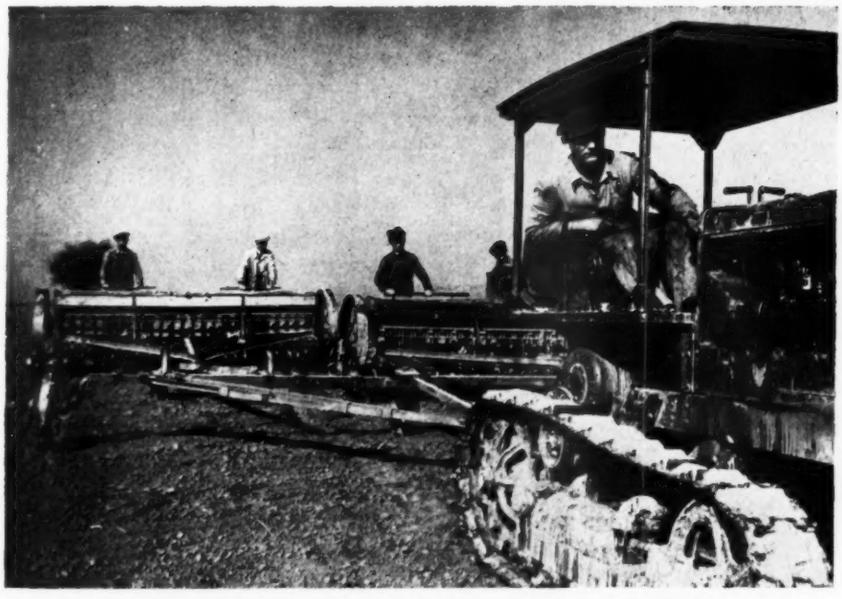
Agricultural machinery, provided by the State, made increased output possible after 1948, when the idea of pooling the land was welcomed by the peasants with understandable enthusiasm. Today only about 5% of the farmers in some highlands are outside the co-operative scheme.

The success of the co-operative system is to a large extent due to increased mechanisation and improved agricultural techniques. There are now over 200 machine and tractor stations in Bulgaria; by 1957 the number of tractors (in units of 15 h.p.) was more than 27,000, with 4,300 combines and 18,200 tractor ploughs.

Special schools have been opened to train mechanics and operators in the use and maintenance of the new machinery. Today there are over 24,000 mechanics and operators on the co-operative farms where formerly on the private farms (*i.e.* up to 1944) there were none. The secondary agricultural schools also train specialists and agricultural institutes provide an ever-increasing number of technicians, agronomists and veterinary surgeons.



Watering the fields near Sofia with a mechanical rain-gun mounted on a tractor



A pair of seeding machines being drawn by a crawler tractor

Extensive scientific research work is also being done, as a result of which 14 new varieties of wheat have been introduced, five new varieties of maize and several new varieties of tomatoes, all with improved qualities.

The country is now covered by irrigation systems fed from five major dams and co-operative farms have built hundreds of smaller dams for their own use.

Because of increased agricultural production per unit of land, Bulgarian farmers obtain better returns under the co-operative system. Table 1 shows increased yields of the basic crops in the 1953–57 period, taking the average yields in 1934–39 period as 100%.

Table 1

Wheat	..	..	107.7
Maize ..	..	..	129.3
Sunflower	..	..	150.3
Cotton..	..	..	290.3
Sugar-beet	..	..	642.3
Tomatoes	..	..	700

Whereas in 1948 3,325,000 persons were engaged in farm work, the number in 1957 was 2,950,000, yet agricultural production rose by about 20%. Production per head of the working peasant population is thus larger today than it was on the private farms.

Technical News

Articles in the June issues of some of the other journals of the Leonard Hill Technical Group include the following:

Atomic World. – 'Radiation and Agriculture' by F. R. Paulsen, B.SC., PH.D., F.R.I.C., F.C.S.; 'Nuclear Energy in Norway'.

Chemical & Process Engineering. – 'British Tunnel Driers at French Butyl Rubber Plant'.

Dairy Engineering. – 'Bulk Handling Developments in Scotland'; 'American Studies in Dairy Management'.

Fibres International. – 'Long Staple Cotton – its Supply and Demand' by C. H. Brown, B.SC.

Public Works and Muck Shifter. – 'World's Largest Underground Hydro-Electric Construction' by John Grindrod.

Specimen copies of the above journals are available on application to Leonard Hill House, Eden Street, London, N.W.1.

Potash

One-day symposium in London

THREE interesting papers were presented recently to the Agriculture Group of the Society of Chemical Industry at a one-day meeting in London under the chairmanship of Dr. O. Owen. The first dealt with the important fundamental problem of the availability and non-availability of the potassium from weathered minerals; the second was a discussion of the relative merits of sulphate and muriate of potash; and the third considered the role of potash in the nutrition of the potato plant and the cause of the blackening of the tuber after cooking. The foliar symptoms of potash deficiency in the plant are a bluish-green discoloration of the leaves, becoming red-brown and leading finally to necrosis. The following is a precis of the three papers:

Potassium in Soils *by P. W. Arnold* (*Rothamsted Experimental Station*)

In most partially weathered mineral soils only a very small fraction of the total potassium is readily exchangeable to other ions. The bulk of the potassium occurs in non-exchangeable (or difficultly exchangeable) forms in potash feldspars, micas and micaceous clays, all of which must be regarded as potential sources of potassium for plant needs. Without an understanding of the nature of the principal potassium-containing minerals and the changes that they undergo on weathering our appreciation of potassium release and fixation problems in soils must remain extremely superficial.

The inherent potassium fertility of soils which, at best, contain sufficient 'available' potassium for only a few years' intensive cropping certainly depends on the release of potassium from mineral reserves. Some of the principles underlying the weathering processes in feldspars and micas were discussed.

It is not surprising that empirical approaches to soil fertility problems are not always as successful as we would wish them to be. Explanations as to why potassium 'fixation' is a problem of agricultural importance in some but not in other soils must, to a large extent, depend on the nature of the weathering products which arise from potassium depletion processes.

The Relative Efficiencies of Sulphate and Muriate of Potash for the Potato Crop *by P. A. Gething* (*Potash Ltd.*)

There has been a striking decrease in the use of sulphate of potash since pre-war, imports in 1939 being 52,000 tons of material compared with 16,000 tons at the present time. Sulphate of potash is no longer used to any great extent on the potato crop, for which it was recommended pre-war and widely used in preference to muriate of potash. Pre-war evidence indicated that the substitution of muriate for sulphate of potash led generally to a reduction in yield of $4\frac{1}{2}$ to 5 cwt. of tubers per acre for every cwt. of chloride applied as fertiliser. German workers have generally concluded that sulphate of potash is the more effective fertiliser, particularly on acid soils. In a long-term trial in Bavaria, in which different forms of potash have been applied since 1914, superior potato yields have been obtained with sulphate of potash, particularly in recent years.

As fertiliser rates generally are more generous than they were pre-war, and as placement is widely practised, it would be expected that there would be an advantage in using sulphate of potash under present-day conditions. In a limited number of trials carried out in 1958 in the North and Midlands, sulphate of potash consistently outyielded muriate. The difference was particularly great at high rates of application (300 lb. K_2O per acre) and when fertiliser was placed in close proximity to the seed. The rates of application used in the experiments varied from 150 to 300 lb. K_2O per acre applied with uniform nitrogen and phosphate dressings. On average, the depression in yield due to using muriate of potash instead of sulphate worked out at approximately 8 cwt. per acre for every cwt. of chloride applied. The magnitude of this difference was probably caused by the very dry conditions which were experienced following planting, germination being more severely delayed on the muriate of potash plots.

Some Aspects of the Potash Nutrition of the Potato *by F. E. G. Harrap* (*Levington Research Station*)

After a general introduction there followed a short outline of the potassium requirements of the potato plant, the effects of potassium deficiency and the general function of potassium in the potato. The relationship between chloride and sulphate source and carbohydrate metabolism was then considered. It was suggested that the nature of the source of potassium, especially with reference to chloride, was less important than the amount of potassium taken up by the plant, though this was invariably higher with the chloride source. The concentration of potassium in the potato plant governs the dry matter content of the haulms and tubers and is probably directly related to the overall starch yield.

The relationship between potassium nutrition and the texture and colour of the cooked potato, whether boiled or fried, was next discussed, reference being made to after-cooking blackening, bruise discoloration, and chip and crisp colour. The subject of potassium nutrition and potato quality was summarised as a result of the field experiments in Great Britain and taste panel tests at Levington.

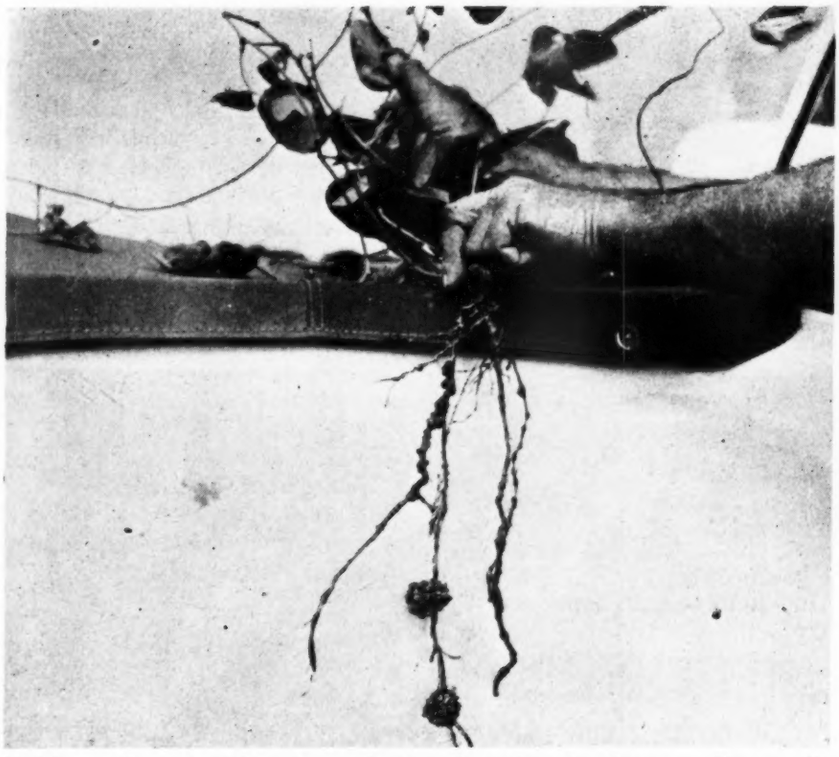
Waterlogging and Salinity

The Chairman of the West Pakistan Water and Power Development Authority, Mr. Ghulam Faruque, has revealed that each year 70,000 acres of fertile land in Pakistan are being rendered waste by fast-spreading waterlogging and salinity.

In two years' time, with the aid of a loan from the World Bank, about 1.6 million acres of waterlogged and salinity-affected land lying between the Rivers Ravi and Chenab would be brought back into cultivation by sinking 2,047 tube wells.

Sugar Cane in New South Wales

2.—The Use of Legumes



Nodules on the roots of leguminous plants, such as the velvet bean, are fibrous galls in which live the nitrogen-fixing bacteria

Summer Legume Crop

THE main advantages of growing a summer legume are as follows: Firstly, the crop protects the surface soil from the damaging effects of heavy summer rains. The action of raindrops on a bare soil destroys the soil structure and blocks up the channels between the soil crumbs. On some soils a hard crust is developed which limits air movement into the soil and produces a 'sour' condition. Again, even on gentle slopes, there is some sheet erosion, as can be seen in the muddy run-off from drains.

Secondly, a legume crop shades the soil. This is important in slowing down the destruction of humus, which takes place when the soil becomes hot. Humus is destroyed in the soil at an increasing rate as the temperature exceeds 77°F. Bare soils, particularly peats, often reach high temperatures, at which there is rapid destruction of humus.

Thirdly, the growing legume is believed to slow up the destruction of humus by certain micro-organisms which are most active on bare, cultivated soils. It is not quite clear how this happens, although it is thought that the growing cane plant has a similar effect. Humus helps to improve soil structure, as it tends to bind the soil particles together into stable crumbs, with all the advantages described earlier.

Finally, there is the value of the legume crop in taking nitrogen from the air through the nodules which grow on its roots. Trials at Bundaberg with velvet beans have given an average of 14.4 tons of green material per acre and with the equivalent of 13 cwt. of sulphate of ammonia per acre. This would cost nearly £40 per acre if applied as fertiliser.

Improved legume crops

Many farmers could improve their methods of handling legumes and get better results by using wilt-resistant and improved varieties of legumes, by preparing a good seedbed, by sowing at the right time, by improving drainage and by inoculating the seed with bacterial cultures.

Poona Pea has been the main legume used for many years. But it is attacked by bean fly and is badly affected by stem rot and wilt, especially in wet seasons or on poorly drained areas. Where it has shown these faults it should not be grown any longer.

Two varieties of cowpea which have proved more satisfactory are *Cristaudo* and *Reeves' Selection.*

Two newer varieties have proved even more successful in tests in Queensland, namely, *Malabar Pea* and *Black Eye No.* 5. Both these varieties are more resistant to wilt than *Poona Pea* or *Reeves' Selection.* A preliminary trial has given good results with *Malabar Pea*, which gave 60% more green material than *Poona Pea. Black Eye* cowpea is susceptible to damage by bean fly.

The velvet bean

Velvet bean has been tried on several farms with striking success. It has many advantages, for it is not seriously affected by bean fly or wilt; it has given good results under both wet and dry conditions and has given a reasonable crop even in dry years when cowpeas have died out; it has a growing period of at least six months, so that the surface of the soil is protected for a longer period than with cowpeas; it can be turned under in the dry state; and, above all, it gives far more bulk of green material than any other green manure crop.

The growing crop of velvet bean, after a few months, has a dense green canopy at least 2 ft. above the ground, while the soil beneath it is covered with a thick layer of dead and dying leaves which are rotting down as the plant grows.

For best results, velvet beans should be sown in rows rather than broadcast. This allows some inter-row cultivation to control weeds and conserve moisture. Some inter-row cultivation is desirable, because the early growth of

The velvet bean protects the surface soil from damage by heavy rain, shades the soil, conserves humus, holds the soil particles together and adds nitrogen

velvet beans is relatively slow and there is some risk of failure, if the surface moisture dries out before the plants are established. The results fully justify this extra work as compared with a roughly broadcast crop. Moreover, planting in rows economises in seed.

Velvet beans should be sown with a cane or corn planter at about 18-in. intervals and with rows spaced at about 4 ft. 6 in. From 12 to 15 lb. of seed per acre are required for sowing in drills. If circumstances make it necessary to broadcast, even although this is not recommended, the sowing rate should be at least 20 lb. per acre.

Mixed legumes

An old practice is being revived by some farmers, who are sowing a mixture of velvet beans and cowpeas. The cowpeas give quick, early growth to compete with weeds and cover the ground, while the velvet beans make prolific growth at a later stage and carry on for much longer, so that the soil is protected for a long time and there is increased bulk of green material to be turned in.

Seedbed preparation

The extra work of preparing a good seedbed, sowing in rows and cultivating the crop in the early stages is worth while in view of the importance of the crop in improving the soil.

Many legume crops in New South Wales are sown too late. It has been shown that plants which are three to four weeks old when the wet season starts are less susceptible to wilt than plants which have just germinated.

Legumes require good drainage just as much as cane or any other crop. This means good deep preparation of the soil, good farm drains and well-maintained surface field drains.

Bacterial culture

A species of bacterium, *Rhizobium radicicola*, must be present in the soil to allow the development of the root nodules which collect nitrogen from the air for the plant. Moreover, special strains of this bacterium are required for different legumes.

Cultures of the various bacteria can be bought ready mixed in agar solution, while others are offered in the dry form to be mixed with water to wet the seed just before sowing.

Working in the legume

Legumes continue to fix nitrogen as long as they grow and therefore the

Ploughing in a crop of field peas which had been chopped with a disk harrow the previous week. About 8 tons of green material are produced per acre, equivalent to 400 lb. of sulphate of ammonia

longer they are left the better. As the plant dies off at maturity the nitrogen from the leaves tends to become concentrated in the stems and roots, and there is little loss of nitrogen even if the plant matures and dies before it is turned in.

Again, the longer the legume is left, the more shade and protection it gives to the soil.

For many years the method of working in was to plough it in deeply with a big single-disk plough. This was really the only possible way in the days of horses and before serrated disk harrows were available with ample power from light tractors.

It is now the best practice to have the remains of the legume mixed evenly through the topsoil. This can be done by using well-sharpened disk harrows, preferably with cut-away or serrated disks. More than one run may be required with a dense crop, and in some cases a shallow working with a plough may be satisfactory after a preliminary chopping up with disk harrows.

They find that the surface soil is kept in good condition for absorbing rain and at the same time reducing evaporation from the subsoil.

Winter Legume Crops

While the growing of a summer legume is definitely recommended, there is a difference of opinion regarding the desirability of growing a winter legume as well. Winter legumes are, however, not being grown as widely as in the past, due to the poor results obtained in recent wet winters.

Some successful farmers strongly favour the winter legume; by proper attention to drainage and cultivation methods they have had continuing good results, for it gets the soil into first-class condition for planting cane.

Winter Fallow

If a winter cover crop is not grown, the main question is whether the land should be kept free of weeds through the late autumn and winter.

Many farmers let the weeds grow and then disk or plough them in at the beginning of spring. The weed growth protects the surface from the damaging effects of beating rain. Although weeds use some of the nitrogen stored in the soil, this is recovered when the weeds are turned in and rotted down.

An alternative practice, if a winter legume is not grown, is to allow the summer legume to die and lie on the surface through the winter. This protects the soil from rain and sunshine, conserves humus and checks the growth of winter weeds.

(*To be continued*)

The third and final part of this article on 'Sugar Cane in New South Wales' deals with tillage and drainage and will appear in the July issue.

Weeds in Temperate Regions—5

Arable Crops, other than Cereals

The Seventh Session of the Fourth British Weed Control Conference dealt with the control of weeds in peas and beans, kale, brassicas and sugar-beet under the chairmanship of Mr. R. G. Heddle.

CROP tolerance, weed susceptibility and the weeds present or possible are the fundamental considerations in selecting a herbicide. The conference considered the merits of various herbicidal chemicals (common name with small capitals) and of some proprietary formulations (first letters in capitals) of these basic chemicals. The manner in which a basic chemical is formulated greatly influences its selective toxicity to crop and weed, and each one must be considered as differing from others with different formulations.

The following is a very brief summary of the eight papers given at this session:

Herbicide Tests on Field Beans *by J. G. Elliott, M.A. (A.R.C. Unit of Experimental Agronomy)*

Although this crop would appear to be suited to mechanisation, its acreage is probably limited by difficulties in controlling weeds, liability to disease and rather low yields. In the absence of an efficient selective herbicide for field beans, weed control has in the past been attempted by steerage hoeing and such small amounts of hand hoeing as are available these days. In an effort to fill this gap in the use of chemical weedkillers the A.R.C. Unit of Experimental Agronomy has, from time to time, tested any chemicals that appeared promising on field beans. In a screening experiment, simazin, dalapon, endothal, CMPP, 2,3,6-trichlorobenzoic acid and sodium monochloracetate were applied at different doses to spring beans. As a result of these treatments, simazin was selected for further investigation.

From these experiments it was concluded that on an Oxford clay soil simazin had little toxicity to field beans at dosages up to 2 lb. per acre, at which rate it is capable of controlling many annual weeds. The yield of beans from the treated plot was significantly higher than that of the unweeded control, and not significantly different to that of the hand-weeded control.

Weed Control in Various Fodder and Vegetable Crops with Sodium Monochloroacetate *by R. H. Hirst and D. L. Martin (Plant Protection Ltd.)*

Sodium monochloroacetate, SMCA, was found to control many weeds in kale and in some other brassicae without undue damage to the crop. Its performance and action were similar to sulphuric acid, without damaging the crop to the same extent, and it was much safer to handle.

SMCA, being a contact weedkiller, is not rain-fast, but 12 hours' dry weather after application was sufficient for susceptible plants to absorb a lethal dose.

This chemical, of low mammalian toxicity, could be safely applied through a farmer's equipment. There was little to choose between high-, medium- and low-volume applications. High volume, however, was not so consistent as medium and low volume, but there was a tendency to higher yields, though with slightly less weed control.

Control of Weeds in Farm Kale *by W. Q. Connold, R. E. Rogers, D. G. Baglow, A. Finn, E. Harris and O. M. Hosegood* (*N.A.A.S.*)

Some 12 experiments carried out in the south-west of England by the N.A.A.S. during 1956 and 1957 confirmed that less crop damage and more effective weed control can be expected from spraying farm kale crops at about the three true-leaf stage than at later stages of growth. Sulphuric acid was found the most generally effective spray against weeds in kale and the only one used with a high degree of success against *Chenopodium album* (Fat Hen). The addition of a suitable wetter increased the herbicidal effect of acid against mature *C. album*, but, because of the increased damage to the kale, its use would only be justified in heavy infestations, and then in well-established kale crops. Potassium cyanate and sodium monochloracetate, SMA, were, in general, effective against *Polygonum persicaria* (Redshank), *Sinapis arvensis* (Yellow Charlock) and *Brassica rapa L. subsp. campestris* (Smooth-Leafed Charlock), provided they were applied early, but almost valueless against *C. album*.

Weed Control in Peas *by J. D. Reynolds* (*Pea Research Station, Peterborough*)

Stubble cleaning prior to ploughing and light harrowings before and after crop emergence, until the peas are about 4 in. high, are useful ways of helping to keep down weeds in the early stages.

Tractor hoeing demands that the crop must be sown in wide rows, which, some evidence suggests, yield less than narrow rows in respect of both threshed peas and vining peas. On the other hand, spraying with dinoseb – the most versatile and most widely used herbicide suitable for peas at the present time – can be carried out in a narrow-drilled crop, although the higher potential yield may be offset, at least in part, by the higher cost of treatment and damage by wheelings.

Pre-emergence contact herbicides are of very limited value for peas in this country, since weeds and crop normally emerge together and post-emergence weed control would, in many cases, still be necessary.

The use of the suitable post-emergence herbicides available – dinoseb (amine and ammonium), MCPA and MCPB – is discussed and brief mention is made of pre-emergence contact and residual herbicides.

Experiments with Propham and Endothal for Controlling Weeds in Sugar-Beet *by A. F. Murant* (*Norfolk Agricultural Station, Sprowston*)

Endothal has insufficient selectivity to be considered as a post-emergence treatment in sugar-beet. A granular preparation increased selectivity slightly in one trial, but failed in another, and it would not appear to be of much value. However, endothal and a mixture of propham with endothal are the most promising pre-emergence treatments for general weed control so far tested on sugar-beet at the Norfolk Agricultural Station.

Control of Wild Oats in Peas *by J. M. Proctor and W. A. Armsby* (*Pea Research Station, Yaxley, Peterborough*)

TCA was found to be much more consistent than propham in controlling wild oats, but invariably affected crop growth at the rates tested. Its use is recommended where wild oat populations are high enough for the risk of some crop damage to be acceptable. Propham is recommended where populations are lower and the chance of a poorer control of the weed is preferable to the possibility of greater crop damage which is involved with the use of TCA. CDAA and CDEC gave unsatisfactory results.

Methods of application and dosage rates are suggested for both TCA and propham so far as maximum wild oat control with minimum crop damage is concerned. Some varietal differences to TCA are indicated.

Control of Wild Oats in Sugar-Beet *by A. F. Murant* (*Norfolk Agricultural Station, Sprowston*)

The paper is a summary of experiments on the control of wild oats, *Avena fatua*, in sugar-beet conducted since 1955. Of a range of chemicals tested, TCA has been the most reliable and satisfactory; propham has also shown promise, but has given less consistent control. Evidence is presented to show that much of the variability with propham, and to a lesser extent with TCA, can be eliminated by more attention to the time and method of application. It is concluded that, if this is done, propham becomes worthy of consideration as an alternative to TCA in many situations.

Control of Wild Oats by Pre-sowing Treatments *by A. J. Butler* (*Plant Protection Ltd.*)

Only TCA and propham at 4 lb. per acre proved to be consistently satisfactory for both wild oat control and minimal crop damage. TCA generally gave rather better wild oat control than propham (68–95%, as compared with 62–92%), but only in one case was there a marked difference. Propham reduced the germination of beet by 20% in one trial, but had little effect in the other five. TCA did not affect germination, but caused about 20% reduction in vigour of peas. Propham gave rather better control of broad-leaved weeds than TCA. Propham at 2 lb. per acre and CDEC at both rates gave unsatisfactory control of wild oats. CIPC at both rates and propham at 8 lb. per acre, although giving excellent weed control, were too severe on the crops.

Pest of Coffee

The coffee root mealy bug, *Pseudococcus citri*, has become a serious pest to both Arabica and Robusta coffee trees in Uganda.

To kill a mealy bug with insecticides is difficult, for it spends most of its life underground. However, the bug is kept alive only by the presence of ants. Not only do they keep it moving from plant to plant, but they also drive off any other insects which try to attack it. These ants are easily killed by an insecticidal dust known as lindane, and now growers are being encouraged by the Uganda Department of Agriculture to sprinkle the dust around the base of a coffee tree every time they see ants there. The cost is slight – generally less than a penny a tree – and the insecticide is perfectly safe to handle.

New Publications

The Coconut Palm

Monograph by K. P. V. Menon and K. M. Pandalai. Pp. 384, 150 diagrams, photographs and colour plates. Ernakulam, India: Indian Central Coconut Committee, 1959. Rs. 38, $11.95, or 85*s*.

The coconut palm, which for many centuries past has had the distinction of being styled *Kalpa Vriksha* or 'Tree of Heaven', still continues to dominate the tropical scene, for, in the areas where it is grown, the economic well-being of the bulk of the population depends on this multi-purpose palm, every part of which is used for some essential purpose.

Of the 8½ millions of acres under this important economic crop, India has over 1½ millions and, after the Republic of the Philippines (2¾ millions), is the second largest producer of coconuts in the world, with an estimated annual crop of over 4 billion nuts. From being an exporter of high-grade copra and coconut oil, India has through its relentless increase in population become a net importer of these raw materials, and it is well known that she is not producing enough coconuts for her people. This is a fact of immense significance, as every other producing country, too, is retaining more and more of its coconuts and coconut products for home consumption.

It is because of this that the coconut-producing countries of the world are taking active steps to improve and develop coconut production and to rehabilitate their failing industries – failing through the senility of the palms and the cumulative deficiencies of soil nutrients where the palms have been long neglected with little, if any, attention being given to manuring and after-care or the proper selection of planting material for the next generation.

The appearance of this massive work is therefore most opportune, but it is also long overdue, as it is now 35 years since the publication of that classic work of the same title by H. C. Sampson, who originated research work on coconuts and is still a revered memory among the staff of the Coconut Research Stations in India.

This monograph contains complete information on various aspects of the coconut palm, including its morphology, anatomy, cytology, physiology, cultural and replanting practices and the identification and control of the many pests and diseases which affect it and reduce its productivity. The bibliography cited in this publication – 891 references in all – is by no means complete, but this is sufficient evidence of the immense volume of research work which has been done since Sampson showed that coconuts are not just 'a lazy man's crop' – a crop which can fend for itself without needing any care or attention.

The Coconut Palm is a perfect example of good team-work – a combined operation in which all the senior officers of the Research Stations at Kasaragod and Kayangulam have participated, and rightly so, as in this age of specialisation no one individual can give a properly balanced presentation of the whole subject. In this connection I would offer just one word of criticism in that the important subject of copra grading is dismissed in three lines, and the even more important one of copra deterioration is not mentioned at all.

On the other hand, the botanical aspects are considered exhaustively and a most interesting account is given of the innumerable varieties and of the causes of the various abnormalities. The sections relating to the pests and diseases of the palm and the relation of soil conditions to their incidence provide much food for thought, as does the rather unusual concluding chapter on problems of research awaiting attention.

Dr. Menon and Dr. Pandalai are to be congratulated on the successful completion and businesslike presentation of this monumental work in so short a time. I feel sure that it will prove of immense value to all research workers, field officers and progressive growers and will provide a standard textbook for agricultural students in all parts of the world.

F. C. COOKE

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Other miscellaneous publications reviewed should be obtained direct from the addresses given.

The Grassland and Fodder Resources of India

The Grassland and Fodder Resources of India, by R. O. Whyte. Pp. 437, illus. The Indian Council of Agricultural Research, New Delhi. 1957. Price Rs. 16, $5, or 36*s*.

The eyes of the politically uncommitted nations of Asia are upon two giants, China and India. What matters to the millions of the East is primarily food, not the choice between totalitarianism and democracy, and the political system which can best provide that food will claim their support. It is against this wider background that one must consider Indian agriculture today and the book under review helps to provide an understanding of the magnitude of the problem.

The information contained in the book was collated while the author was working first for the Government of Uttar Pradesh and later for the Government of India under the Expanded Technical Assistance Programme of FAO. The book itself is an attempt 'to review the past and present knowledge and experience on the nature and utilisation of the grazing and fodder resources as a whole and to relate this information to other branches of land utilisation, agriculture, animal husbandry and forestry in India'.

This vast subject covers: the livestock problem; demand, supply and competition for resources; feed resources and quality; ecology of vegetation; grassland types; fodders, feeds and concentrates; government and military farms; village grazing lands; nomadic and migratory grazing; grazing in forests, and its regulation; soils and fertilisers; plant breeding and seed supplies; mixed farming; the agrarian structure; and grasses and legumes. One can only congratulate

the author on the way he has assembled and presented so much relevant and valuable information.

There are many excellent illustrations and 16 pages of references. In a work of this wide scope the geographical, subject and plant indexes are entirely necessary and the glossary of Indian terms is invaluable.

W. LINNARD

Agriculture in Japan

An Introduction to Agriculture in Japan by Seiichi Tobata. Pp. 74, illus. Published by Agriculture, Forestry and Fisheries Productivity Conference, Tokyo. 1958. Price $1.50.

The author outlines the salient features which have dictated the development of agriculture in Japan, describes the structure of agricultural production and summarises the forces activating a new era of agricultural progress in Japan.

Japanese agriculture has been mainly concerned with production of foodstuffs, animal husbandry playing only a very minor role. Arable land is used intensively and almost continuously, with rice occupying more than half of the entire area. This system, covering a wide range of climatic conditions, provides 80% of the food consumed in Japan. Although self-sufficiency in food has been advocated as the guiding principle for the six million families cultivating 14 million acres, close adherence to this principle without progress towards balanced nutrition can, in the author's view, lead to tragic results.

The two dominant factors in Japanese agriculture are scarcity of land and over-abundant labour. Under these circumstances emphasis is placed on economising land rather than labour. As the author remarks, the Japanese farmer is a master of land-saving devices, but remains a mere child as far as labour-saving devices are concerned. These facts have determined the direction of technological progress towards intensification of cultivation by the increased use of fertilisers and seed selection, resulting in the world's highest acreage productivity, regardless of farm economy or marketing.

Significant changes in agricultural policy are predicted. The growth of democratic ideas has led to land reform whereby almost all tenanted land has passed into peasant ownership. While this has not alleviated population pressure, it has awakened the cultivator's initiative. Agriculture as a business is now possible for farmers who keep up with the astonishing technological progress. The author reminds us that it is a mistake to speak of general agricultural progress; there are, indeed, some very prosperous farmers, but also many poor peasants, the latter being the more numerous. The fact remains that agricultural progress has not advanced *pari passu* with other industries; indeed, the relative importance of agriculture has declined with the increase of industrialisation.

While retaining its pre-eminence, ways must be found to break the rigidity attached to rice cultivation by allowing a wider rotation of crops, such as rice-roots-wheat instead of rice-wheat, thereby permitting further development of animal husbandry. The rapid progress in mechanisation of farming operations has special significance in the attainment of this objective.

Subsidies to agriculture will be continued and Government investment in large-scale projects, such as land reclamation, irrigation and drainage, are to be intensified. These incentives are accompanied by the rapid growth of education and research, the latter being directed particularly to the economic and sociological aspects of agriculture.

The above is but a bare outline of the main argument in this very able survey of Japanese agriculture. The full text will amply repay careful reading. The author is a master of his subject and writes with great feeling. The book is attractively produced, is written in excellent English and contains a map and 35 beautiful illustrations covering many aspects of Japanese agriculture. It is undoubtedly the best Japanese book on this subject that has yet been published.

D. H. GRIST

A.E.A.'s New President

The new President of the Agricultural Engineers' Association, Mr. Leonard C. Pearch, M.I.Mech.E., M.I.B.A.E., is the Chairman and Managing Director of Kent Engineering and Foundry Ltd. His firm was the first to develop fruit-spraying equipment drawn and powered by farm tractors and they were the first to introduce air-assisted spraying equipment into Europe. He himself has been instrumental in the establishment of the Colonial Spraying Centre, Silwood Park, Sunninghill, Berkshire

Other Publications

Publications also received include:

Planning of Experiments by D. R. Cox. John Wiley & Sons Inc., 440 4th Avenue, New York 16. Chapman & Hall, 37 Essex Street, London, W.C.2. Price 60*s*.

Third Report on the Agricultural Policies in Europe and North America. Report prepared by the Ministerial Committee for Agriculture and Food and published by the Organisation for European Economic Co-operation, 2 rue Andre-Pascal, Paris XVIe. 1958. Price 24*s*.

Review of the Agricultural Situation in Europe at the End of 1958. Statistical report by the Committee on Agricultural Problems of the Economic Commission for Europe of the United Nations, Geneva, 1958. Price not stated.

Agricultural Mechanisation – Harvesting and Storage of Grain Maize. Report prepared by M. Rauscher, Director of the Centre National d'Etudes et d'Experimentation du Machinisme Agricole. Tenth Report of the Working Party of the Committee on Agricultural Problems of the E.C.E., United Nations, Geneva, 1958. Price 3*s*.

Ninth Session of the Conference, 2–23 November, 1957. Food and Agriculture Organisation of the United Nations, Rome, Italy, 1958. Price 16*s*. 3*d*.

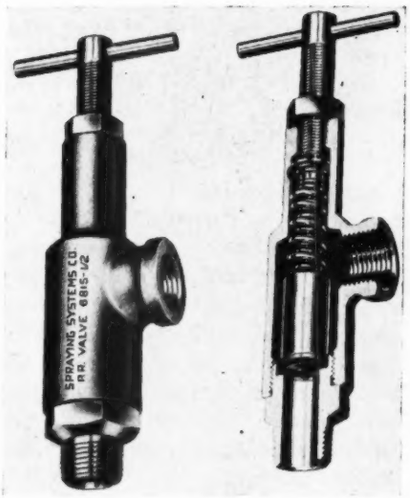
Machinery and Equipment

Irrigation from Deep Wells

The new *International Harvester* U-450 power unit and a *Deming* 12-in. pump will lift water from a well 820 ft. below the ground and deliver 1,200 gal. per min. for the irrigation of orchards and citrus groves. This 126-h.p. power unit is typical of others in their new 68- to 133-h.p. series; they all have the modern square grille and cowel design.

Resistance to Abrasion

Chemicals used in farm spraying sometimes contain highly abrasive particles that can cause rapid wear where liquid flow is closed down to a narrow opening. One such point of wear in a pressure relief valve is in the valve and seat zone. The parts here are made to a high degree of accuracy and so excessive wear could cause faulty valve operation. In the new *Spraying Systems Co.* 6815-1/2 H.S.S. pressure relief valve the valve guide and inlet adapter are fitted with hardened stainless steel inserts to provide an extremely high degree of resistance to abrasive wear, and the rest of the unit is made of brass, with stainless steel springs. Two springs with different tensions are provided, with the lighter spring controlling lower pressure settings and the heavier spring controlling higher pressure settings. These dual springs give extra sensitivity to overall pressure adjustment range up to 300 lb. p.s.i. Other features include an extra-large valve passage for handling full flow from the supply line up to $\frac{3}{4}$-in. pipe size and a pressure-setting lock which will not loosen under the shocks and vibrations fo spraying operations.



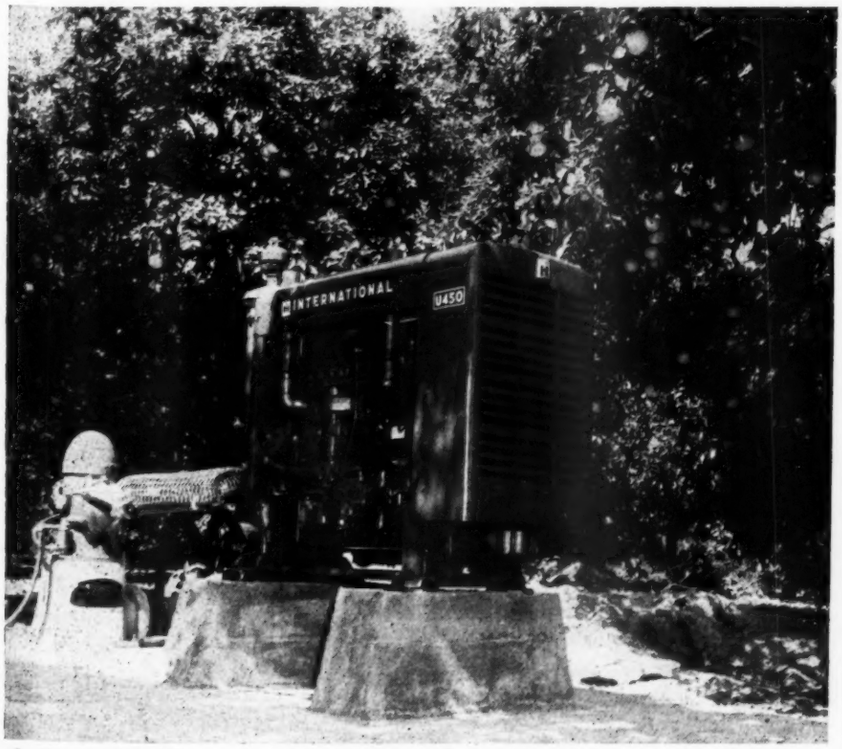
Section cut through a Spraying Systems pressure relief valve to show dual springs

Motorised Washing Operations

Owners who are proud of their mechanised farm machines should ensure that they are washed down daily and properly oiled, greased and maintained. The ' Neptune ' high-pressure water pump, which can be attached to the p.t.-o. of a tractor in a few seconds, will ensure that all tractors and implements are kept in sparkling condition.

A working pressure of 200 lb./sq. in. and a delivery rate of 1,000 gal. per hour are obtainable at normal p.t.-o. speeds. The pump is supplied complete with 26 ft. of high-pressure hose and two nozzles – one for high-pressure washing and one with an adjustable spray.

There is also a portable motor-driven model for swilling out poultry cages, piggeries, incubators, dairies, lorries and other farm vehicles. It would also be useful for washing down house drains and monsoon drains in the tropics and for spraying around living quarters and labour lines against mosquitoes and flies.



An International harvester power unit of 133 h.p. with a 12-in. pump for irrigating a citrus grove in California

About Hose

B.T.R. Industries Ltd. have produced a new catalogue of their products, ranging from slender laboratory tubing to suction and irrigation hose of over 18 in. internal diameter and made of various materials to suit different purposes. They fall into two main groups: wrapped, mandrel-built

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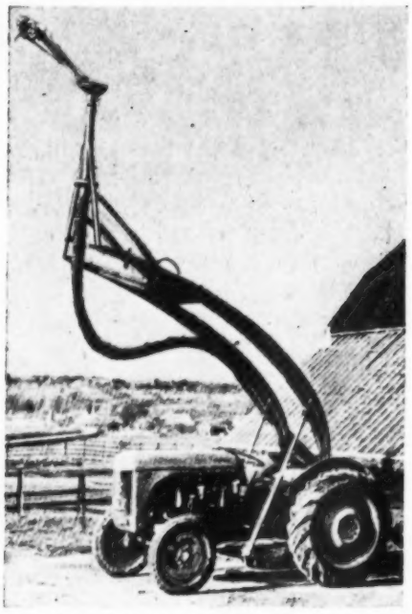


Overhead irrigation with a Farrow raingun mounted on a high-lift loader for getting above tall crops, such as hops, sugar-cane, coffee etc.

hose and long-length, moulded and braided hose. The former covers the wider range of applications and has a larger number of sizes and types.

Fabric-wrapped hose is built up on rotating steel mandrels which form and accurately control the bore and produce a seamless tube, normally about 60 ft. long. The mandrel forms and accurately controls the bore, remaining in position until vulcanisation is complete. Component compounds and processed fabrics are then built into the hose and this ensures maximum adhesion over the whole hose if it is done immediately after vulcanisation.

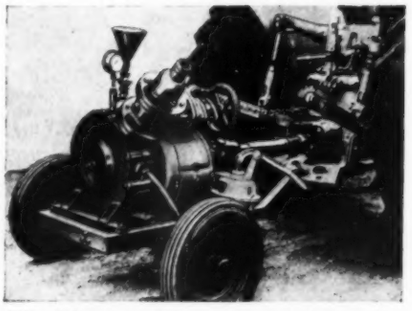
Rubber covers are built up from thin sheets to a specified thickness on the hose and this ensures even thickness and concentricity of the cover. Before vulcanisation all hose is tightly wrapped first with a fine fabric applied longitudinally and then with a fabric applied spirally. The whole is then vulcanised and removed from the mandrel.

Neither mandrels nor cloth wrappings are used in the manufacture of long-length moulded and braided hose and the only reinforcement is by braiding. Textile yarns of the required strength are machine braided over a seamless tube. During vulcanisation the hose is filled with hot water at a predetermined pressure, which ensures that the tubing will have the correct internal diameter. Consolidation of the whole is effected by the application of a seamless lead casing, which acts as a mould and is cut away after vulcanisation.

By this process lengths of hose as long as 500 ft. can be produced up to and including tubes of 1-in. internal diameter; tubes of larger bore are available in 250-ft. lengths, the largest by this process being 1½ in.

Organic Irrigation

'Organic irrigation is the modern approach to muck', according to *Farrow & Sons Ltd.* In animal husbandry, they state, a great deal of time, thought and money have gone into the kitchen and foddering arrangements and practically none into the plumbing. Organic irrigation is, however, not only the modern approach to dairy sanitation, but it also ensures the better conservation and utilisation of the urine and excreta of farm animals, all leading to more hygienic conditions and better crops.



The Morrison p.t.-o. operated pumping unit being drawn behind a tractor

At present muck spreading is done by machines which are subject to heavy wear and tear and do damage to the fields by the effect of heavy traction in consolidating the soil. Heavy wheels churn up gateways, make deep ruts and dirty the public roads. Some fields do not get manured when they should because they may be impracticable of access, and success will be dependent on a sufficient rainfall.

With organic irrigation, using water as the vehicle of transport, there is no mess, no journeying, no damage to soil structure, and practically no wear and tear to equipment, and the labour requirement is reduced to a minimum. Steep fields and fields difficult of access all get their fair dose and the high dilution obviates risk of leaf burn.

The requirements are an adequate drainage system, a cesspit containing an agitator, a suitable pump and irrigation equipment, consisting of aluminium piping and a special raingun for spreading over the grassland or field crop. The pumps used for this kind of work are specially designed to deal with a liquid containing clots, straw and other solid detritus to be expected from the cesspit and they are usually piston pumps fitted with specially designed valves. The pipeline and raingun are, however, standard irrigation equipment.

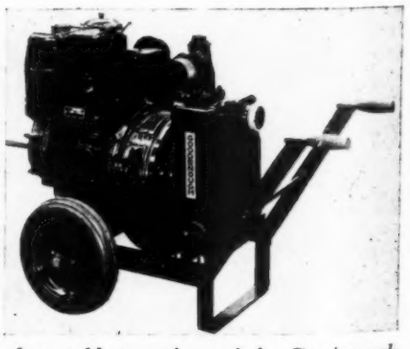
Spray Irrigation Equipment

The spray irrigation equipment by *Morrison Pumps Ltd.* has a new type of bayonet coupling with no latches or loose parts. It is only necessary to insert the end, give a quarter turn, and the coupling, which has a 300 total movement, is locked. The two ends of the pipe are protected from mechanical damage by a casting and the joint is sealed by a rubber ring.

To supply the system they offer a range of vertical-spindle, deep-well jet pumps and also a tractor-operated pump. The former are built in sizes from a small ½-h.p. electric motor-driven model up to a 200-h.p. diesel-driven pump for wells up to 200 ft. deep. The tractor model is operated from the p.t.-o. through a built-in step-up gearbox and the unit is mounted on a two-wheel trailer.

Portable Pumping Unit

The latest '*Goodenough*' Model 315LD is a compact and portable 3-in. diesel-driven pumping set incorporating the *Lister* SL1 air-cooled engine. The close coupling of pump and engine



A portable pumping unit by Goodenough Pumps Ltd., which would be very useful for watering fruit trees from shallow wells during periods of drought

and the cushion-tyred trolley mounting ensure easy handling on difficult sites.

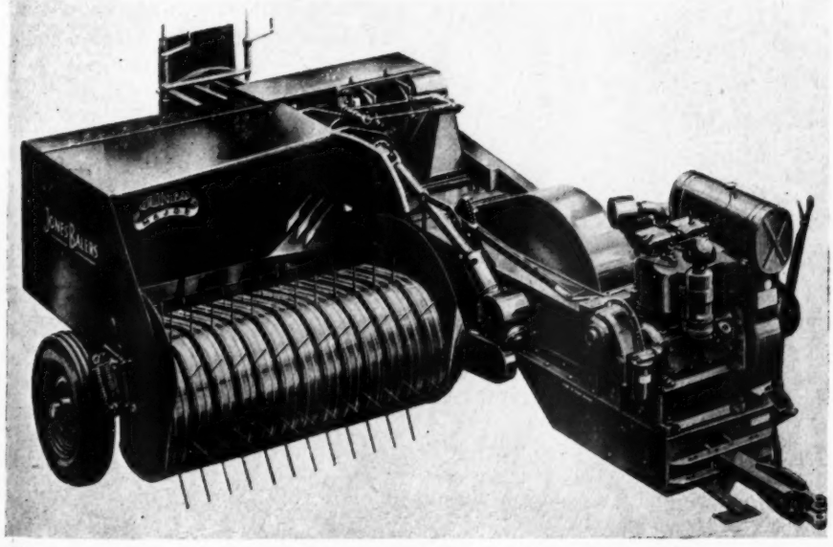
The pump is of the automatically self-priming centrifugal and exceptionally fast repriming is obtained up to a suction lift of 25 ft. This robust pumping set is capable of handling sandy and muddy water containing up to 25% solids in suspension.

The seal is a dual-faced unit housed in an oil reservoir outside the pumping chamber. The impeller is of the four-vane, open-trash type manufactured in manganese bronze, and the pump body is fitted with a steel renewable wearing plate. The malleable iron discharge branch is fitted with a filler plug and provision is made for draining and cleaning out the pump when necessary. The two-wheeled carrier is fabricated in steel and provided with removable legs and handles.

Automatic Baling

Jones Balers Ltd. have recently completed a large new factory in North Wales in order to be able to cope with world demand for their machines. These include the new ' Minor ' Mk. IV, the ' Royal ' baler and the ' Major ', all of which may either be operated from the p.t.-o. of a tractor or can be self-powered.

Their latest – the ' Minor ' Mk. IV – is a compact machine 7 ft. 10 in. wide, 14 ft. 9 in. long and 4 ft. 6 in. high, and it weighs 1 ton 7 cwt. The transmission is totally enclosed and so works with complete safety to produce firm, well-formed bales 14 in. by 18 in. and from 20 in. to 36 in. in length, as required, at the rate of six per minute. The unique new feature is in the chamber design, which forms bales with a recess for the twine, which makes it virtually impossible for the twine to slip off and also uses less twine. These grooves also assist in the aeration of the stacked bales.



The Jones ' Major ' automatic twine-tying pick-up baler as fitted with its own engine

Drainage and Irrigation Trenches

J. C. Bamford (Excavators) Ltd. have now produced another new addition to their range of accessories for their versatile excavator, the J.C.B. ' Hydra-Digga '. It is an 8-in. to 12-in. ejector bucket for land drainage work and pipe-laying. They have a dual application in that they can be used as an ejector bucket when working in heavy clay, such as the coastal alluvium of Malaya, or by the removal of a retaining link they can be used for more rapid action when working in a light sandy soil for the construction of minor irrigation channels. The working rate for this attachment, when digging a trench 2 ft. 6 in. deep, is 2½ to 3 chains, or 200 ft. per hour.

A Howard ' Gem ' diesel rotavator, fitted with special large-diameter steel wheels, being used for puddling prior to planting paddy seedlings

This useful new implement for the J.C.B. ' Hydra-Digga ' is for digging narrow trenches for land drainage and irrigation purposes

Mechanising the Mamotti

The implement of primitive man for cultivating the soil was a pointed stick; subsequently he used the shoulder blade of a deer. Then came the Iron Age and he patterned the mattock. That was thousands of years ago, but today in the more backward parts of the world men still use this primitive implement – it is called the *mamotti* in India, the *chongkil* in Malaya and the hoe in England. With this crude tool smallholders are attempting to meet the growing needs of their ever-growing families, for with each succeeding generation population is doubling and doubling again and more and more land must be cultivated.

It seems strange that it has taken several thousand years to devise some form of rotating cultivator. This was

the position until an Australian – A. C. Howard – tried out the idea of fitting an L-shaped blade to the engine of his motor-cycle and so, some 25 years ago, the principle of rotavation was born.

In the *Howard* rotavator of today a number of these L-shaped blades are mounted on a rotating shaft, which is powered by a petrol or diesel engine and is carried on a pair of land wheels. The rotor, which revolves in the same direction as the driving wheels, assists the forward motion of the machine, while exerting a positive cutting and dividing effect on the soil by means of blades or tines, made of tempered steel.

There is a differential lock, which gives the effect of a solid axle when the machine is being used for cultivating; then, when the rotor gear is put into neutral, the differential is automatically unlocked, greatly facilitating turning at headlands. Brake drums are also fitted separately to each wheel to ensure ease of turning in deep mud. Finally, there is the new ' Selectaspeed ' gearbox, a very simple but effective device for varying the speed of the machine to suit the job, whether it be rotavating and turning in crop residues, ploughing, hoeing, cutter bar work or fast road work.

Already there are several thousands of these machines at work in the vast paddy fields of Siam, each doing the work of six buffaloes and six men. Labour saving, however, is not its main appeal; the real advantage lies in the fact that with the same number of men working it is possible to cultivate six times the area of land during a short spell of weather favourable for cultivation.

Water Weed Clearance

Millions of pounds, dollars and rupees are spent annually on the almost hopeless task of keeping tropical rivers, transport canals, irrigation drains and shallow lagoons clear of weeds. For years this work has mostly been done by manual labour, but the growing scarcity of labour for this heavy and difficult work and rising wages have worsened the position. The hidden loss to agriculture through the lack of effective drainage and irrigation is indeed immense.

One answer to the problem is by the employment of mechanical methods using power-driven launches fitted with special weed-cutting implements. *Howard and Dennis* launches are of shallow draught with a flat-bottomed hull and sloped ends. They are propelled by paddle wheels, fitted at the stern of the launches, and the propulsion unit is hinged radially so that it can act as a rudder. The cutting gear consists of a number of tempered steel blades riveted on spring steel and mounted in the form of a ' V ' on the end of an arm which projects from the front of the launch.

The cutter arm is lowered by means of a small hand winch until its guiding shoe is resting on the bed of the waterway, and, since the arm is hinged, the cutters automatically follow the contour of the bottom from the shallowest water down to a depth of 7 ft., at which depth the arm operates in the suspended position. The clutch which drives the cutting arms and causes them to be oscillated rapidly is then engaged and this produces a positive cutting action which no reasonable aquatic growth can resist.

The ' Landmaster ' 150 being used in Ceylon. Here it is being used for ridging ploughed land to give ridges from 12 to 20 in. in width

Where it is necessary to remove the cut weeds, the following procedures can be used: On rivers or canals, where there is some movement of water, light booms can be arranged across the waterway to hold up the cut weeds, which can be collected there and removed. This operation can either be done manually or by means of special floating elevators, which lift the weeds from the water and deposit them on the bank, or by wheeled elevators, which do the same work, but operate from the banks.

When cutting the weeds in lakes, lagoons and reservoirs, where there is no movement of the water, rake attachments are fitted to the launches, so that the cut weeds can be pushed to a convenient collecting point for their disposal. The company also supply trailers for transporting the launches from one waterway to another and hand winches for launching them into or removing them from the water.

Wet or Dry Cultivation

The *Landmaster* 150 is a multi-purpose tool designed to meet all the needs of the small farmer or market gardener with up to 40 acres of land and to provide a useful additional implement on larger farms and plantations.

A simple adjustment makes it possible to turn the basic machine into a rotary cultivator, a ridger, an efficient plough, a scythe, a fixed tool cultivator or a pumping machine in only a few minutes. It may be fitted with a kerosene oil engine, if so required.

Particular attention has been paid to the needs of rice growers in the Far East and other tropical areas, and many trials have been made under the most severe conditions. The reversible plough is easily attached to the L150 by a single pin for wet rice and dry land farming. Ploughing can be done on wet land, as the extension wheels fitted to the sides of the rubber-tyred traction wheels provide the additional grip necessary to enable the machine to cope with almost any wet soil condition.

On dry land, ploughing depth varies between 6 and 8 in., depending on the soil. As the machine is reversible, the sods can be turned either to the left or the right at the turn of a lever.

Puddling and levelling operations in the wet rice fields can be carried out simultaneously by attaching the puddling rotors as well as the levelling rake, the machine being completely sealed against the entry of mud and water.

On coconut, tea, coffee or cocoa plantations, manures can be worked in the soil in a fraction of the time taken by a man using the *chongkil* or *mamotti*.

Agricultural Chemicals

Bracken Control

Trials over three years in Scotland have shown that bracken can be cleared by spraying with 'Weedone Brackontrol' – a new low-volatile hormone weedkiller formulated originally in U.S.A. by *Amchem Products Inc.*

Preliminary tests begun in 1955 were so successful that in 1957 full-scale trials were undertaken on plots spread over a wide area in Scotland. The results showed that the chemical was translocated from the fronds of the bracken down into its rhizomes, where it killed both buds and rhizome tips. The effective dose was found to be 1½ gal. per acre. Spraying by helicopter gave most promising results, as 10 acres could be treated in one flight.

Further trials, using an improved and cheaper formulation, were undertaken in 1958. These showed that the best time to spray was when the fronds were fully expanded and able to absorb a maximum dose of herbicide – from the middle of July onwards, depending on location and season. One spraying then will give at least 80% and often 90% reduction in bracken growth the following season. The fronds that do emerge the year after spraying are mostly small and weak, enabling farmers to put cattle and sheep on the ground which, by good husbandry in successive seasons, should soon be completely cleared and restored to production.

It should be noted that grass is unaffected by the new weedkiller, but at the high rate applied to bracken it is dangerous to all growing crops and is liable to damage both heather and trees. The treatment is, however, harmless to birds and animals.

'Weedone Brackontrol' will be manufactured in U.K. under licence solely by *A. H. Marks & Co. Ltd.* and distributed by *Plant Protection Ltd.*, *J. W. Chafer Ltd.* and *Vitax Ltd.*

Nitrogen for Wet Rice

From the *Nitrate Corporation of Chile Ltd.* has been received an interesting and challenging newsletter on the subject of the 'Nitrogen Fertilisation of Wet Rice, with special reference to the use of Chilean Natural Nitrate' and giving the findings of research workers in various countries – Information Bulletin No. 32.

For some years there has existed a widespread idea that sulphate of ammonia is the most reliable nitrogenous fertiliser for wet or lowland rice and that Chilean nitrate does not give such good results on this crop. It is also sometimes alleged that the method of applying Chilean nitrate is more difficult, whereas the other can be applied without any special precaution.

The information sheet refutes this and claims that there is ample scientific evidence to show that, if Chilean nitrate is properly applied to wet rice, it can be just as effective as sulphate of ammonia. Actually research has shown that Chilean nitrate often gives better results than sulphate of ammonia, as the continuous use of the latter on wet rice lands tends to increase the acidity of the soil and could produce toxic effects which would limit crop yields.

However, they have entirely different characteristics and should not be applied in the same way. Sulphate of ammonia must be worked into the lower zone of the soil in order to reduce loss of nitrogen. This is not necessary with nitrate of soda, which should be applied to the superficial or oxidising layer of the soil.

The concluding observation is that under certain conditions an application of Chilean nitrate and sulphate of ammonia in equal parts can be expected to give better results than either used alone.

Reader Service

For further information on any item reviewed in this issue please write to:

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Birth of a New Pesticide

The well-known firm of Bayer was founded in 1863 in the wash-house of one of the slate-roofed houses of Elberfeld by Friedrich Bayer. The Leverkusen works, near Cologne, were built between 1891 and 1895, and by 1912 had reached almost their present size.

Testing a new agricultural chemical in one of the glasshouses of the Biological Institute at Leverkusen, in which it is possible to control the atmospheric conditions to produce various climatic conditions

To the initial manufacture of dyestuffs were added pharmaceutical products, such as phenacetin in 1888 and the discovery of aspirin in 1899.

Farbenfabriken Bayer A.G., as the company is now known, is comprised of works at Leverkusen and others at Uerdingen, Dormagen, Wuppertal-Elberfeld and the Agfa Camera Works at Munich. The company employs about 52,000 people and there are some 29,000 patents registered in the name of Bayer throughout the world.

In 1954 Bayer decided to market once again some of their crop protection products in Great Britain. To this end *Baywood Chemicals* was set up in conjunction with *Burt, Boulton & Haywood Ltd.* Since that date Baywood Chemicals have marketed a number of outstanding chemicals emanating from the research laboratories at Leverkusen. Examples of these are 'Metasystox', which has done so much to help the sugar-beet industry, and others such as 'Pomarsol Forte', 'Dipterex 50' and 'Morkit 80'.

The evolution of a new crop-protecting chemical is, however, a complicated and expensive business. There is, of course, no limit to the number of permutations and combinations and the structural arrangement of the basic chemical elements which go to make organic chemicals. In the course of a single year Farbenfabriken Bayer produce about 2,000 new chemical compounds, whose characteristics are carefully studied and considered; of these, only two, three or four may show promise for use either as a rodenticide, fungicide, insecticide, tranquilliser or weedkiller, but this is only the beginning. There is a long way to go before a new compound is presented in a satisfactory formulation which is acceptable in all respects – effectiveness against the pest, safety in use, safety to the crop, absence of toxic residues or taints and, of course, satisfactory in price.

Insecticide for Cotton

'Sevin' insecticide, a new type of pesticide, is now offered for the control of all major cotton insects by the *Union Carbide International Co.*, who will supply it to selected manufacturers for the production of dusts containing from 5 to 10% of the active ingredient.

The new insecticide is a carbamate and is quite different from the chlorinated hydrocarbon and phosphate insecticides now being used. In field tests the insecticide has successfully controlled boll weevils and other insects which had developed resistance to existing insecticides. It is an effective residual boll weevil killer and gives outstanding control both of bollworm and pink bollworm.

The relative safety of 'Sevin' to warm-blooded animals, which has been shown in many tests, means less hazard to persons who handle the insecticide. The formulated dusts have handled well in both ground and air equipment and are completely stable when properly stored.

The recommended application for this insecticide is ½ to 1 lb. of active insecticide per acre (560 to 1,120 g. per ha.) for early season control of thrips and fleahopper. For mid-season and late season control of boll weevil, bollworm, pink bollworm, aphid, leafworm, lygus bugs and leaf perforators the dosage is 1 to 2 lb. of active ingredient per acre (1,120 to 2,240 g. per ha.) applied every five to seven days. The insecticide should be applied prior to the opening of the boll.

Multi-wall Paper Sacks

In post-war years the use of multi-wall paper sacks for the packing of agricultural chemicals, composts and similar solid materials has steadily increased and they are no longer merely a substitute for tins, drums and sacks.

The development of suitable handling techniques and handling facilities, together with the design of suitable weighing, filling and closing equipment, have considerably assisted the ready acceptance of the paper sack. Not only has this package proved to be satisfactory and economical for such products as cement, lime, fertilisers, agricultural chemicals and horticultural products in the home trade, but they are now being used successfully for overseas shipments.

Multi-wall paper sacks are manufactured by *Imperial Chemical Industries Ltd.* from a special kraft paper made from a wood pulp produced by the sulphate process, which results in a very strong material. They are made in seven main types and in different paper thicknesses to suit different purposes.

The thickness or substance of a paper is conventionally denoted by the term 'lb./D.C. ream weight'. This is the weight in pounds of 480 sheets 20 in. by 30 in. in size. The plain kraft paper used in plain multi-wall paper sacks is thus described as 27–40 lb./D.C. There are also specially treated papers for special purposes.

Aluminium Mulch

'Star' garden foil, when laid between rows of plants, gives a number of benefits. It retains soil moisture, suppresses weed growth and reflects the sun's rays on to the underside of the plant so that fruits like tomatoes and strawberries obtain all-round ripening. The foil also provides against excessive heat and cold, so speeding plant, fruit and flower growth. Obviously, by keeping down weeds and grass, it will save many hours of hoeing and cultivating. Laid down beside seedbeds it will act as a bird scarer and it will also keep off slugs and creeping insects and prevent mud splash. Arranged vertically it can be used to reflect the sun to ripen fruit more quickly. Recent experiments using aluminium foil as a moisture vapour barrier in the steam cultivation of mushrooms have reduced the growing time by one-third.

The material is obtainable from the *Star Aluminium Co. Ltd.* in handy 6-in. rolls, each 50 ft. in length. It has obvious uses not only to the market gardener, but also in research.

Plastic Sandwich

'Fome-Cor' is a sandwich of foamed plastic and paper cemented together by a continuous process to give a new packaging material which retains its rigidity and high-compression strength under severe moisture conditions, provides good insulation and cushioning properties and is light in weight. It has a broad range of uses in partitioned containers for the dispatch of fruit and plants by road, rail, air or sea.

The product is being manufactured in three forms or grades and the *St. Regis Paper Co.* and *Monsanto Chemical Co.* have announced the formation of the *Fome-Cor Corporation* to manufacture and market the product.

World Crop Reports

INTERNATIONAL REPORTS

Cotton

World cotton production in 1958–59 is estimated at the record level of 44 million bales (500 lb. gross weight). This is 0.5 million bales above the previous record world crop of 43.5 million bales in 1955–56, and is 2.3 million higher than in 1957–58.

In the *U.S.A.* yield per acre is placed at the record level of 469 lb. for the 1958 crop, compared with 388 lb. in 1957 and the previous record of 417 lb. in 1955. Acreage harvested was the smallest since 1876, with 5 million allotted acres removed from production under the Soil Bank programme. Cotton ginned prior to 16 January, 1959, totalled 11.3 million running bales, or 98.6% of the total estimated crop.

Production in the *U.S.S.R.*, mostly on irrigated land, may total 7 million bales in 1958–59, which is equal to the record 1956–57 crop, and is slightly larger than last year. Reports indicate a record crop in *China*, although there is some speculation concerning the amount of the increase above last year's record level of about 7 million bales. On the basis of revised statistics U.S.S.R. and China are now producing roughly a third of the world's cotton, compared with one-quarter in the 1950–54 period.

Excluding U.S.A., U.S.S.R. and China, world production is currently estimated at a record 17.3 million bales this season. This is 0.6 million bales above the previous record of 16.7 million in 1957–58 and 3.5 million above the 1950–54 average. Larger production of extra long staple cotton, mostly in *Egypt* and *Sudan*, accounts for the increase over last season. Indications are that total production of upland cotton in these areas will not vary greatly from last year. Production estimates for *India* and *Pakistan*, where most of the Asiatic-type short staple cotton is grown, are now lower than last year as a result of adverse weather.

Production of upland cotton in *Mexico* and *Central American* countries is at a record high level in 1958–59 as a result of increased acreage and generally favourable growing conditions, despite some local weather damage in Mexico. Production also is expected to reach a record in *Uganda*, *Iran*, *Colombia* and *Tanganyika* and crops are larger than a year earlier in *Turkey*, *Mozambique* and *Spain*. These increases are partly offset by smaller crops than last year in *Argentina*, *Brazil* (northern area), *Nigeria*, *Syria* and *Iraq* and lower production of upland types in Egypt.

Harvesting a record wheat crop in Australia. The farms are highly mechanised and bulk handlig methods have been adopted

Oils and fats

Annual world production of fats and oils used for food has increased by 9 million tons in the past 10 years, according to a report by FAO. Production was 28 million tons in 1958, about 50% more than the average pre-war level.

Major increases were registered in the *U.S.A.* and the *U.S.S.R.* – about 2 million tons in each case. Increases elsewhere have been: *Western Europe*, 1.1 million tons; *China*, *India* and the *Philippines*, 1 million tons; *Africa*, 700,000 tons; *Latin America*, 600,000 tons; and *Eastern Europe*, about 500,000 tons.

This increased production of fats and oils has come from only a limited number of sources.

In Western Europe the source has been mainly animal; in Africa, oilseeds and groundnuts; and in the U.S.A., soya beans. Copra has been the source in the Far East and in comparison the one which has expanded most, despite a recession in the past two years.

REGIONAL REPORTS

Australia

Pre-harvest estimates for *wheat* were for a total yield of 210 million bushels, but seasonal conditions have been so favourable that agronomists of the Australian Bureau of Agricultural Economics consider that final returns may be even greater than the record 220-million bushel harvest of 1947–48.

The yield per acre this season will be considerably higher than in 1947–48, when nearly 14 million acres were under wheat and the average yield per acre was 15.86 bushels. The area of the present crop is not expected to be more than 11 million acres.

The largest producing State is New South Wales, where a harvest of 67 million bushels is expected.

South Africa

Temperatures in the Union of South Africa, especially toward the end of December, were very high and some growing areas reported sun damage to fruits. *Fruit* had ripened much faster than in previous seasons, causing delivery for export of an exceptionally large volume of fruit, which overloaded handling facilities. Much fruit has been rejected for over-ripeness.

It is now estimated that the 1958–59 apple crop will be somewhat below last year, but prospects for pears are good. In general, the outlook is favourable for stone fruit crops, particularly peaches for canning.

Northern Hemisphere

Production of all types of *citrus* fruit except limes in the Northern Hemisphere in the 1958–59 season is estimated above last year and all types except grapefruit are significantly above average. These increased supplies are primarily a result of larger crops in Spain, Italy, Israel and the U.S.A.

The Mediterranean *orange* crop is estimated to be about 17% above 1957–58 and more than 25% above average.

Spain's large citrus crop marks renewed production in the areas where navel and non-blood oranges are grown. Spain's oranges are above average in size this season and in Israel the new plantings are coming into bearing. Supplies of Israeli citrus can now be expected to increase each year.

The Northern Hemisphere has a 1958–59 *lemon* crop estimated at 31.7 million boxes, up 700,000 boxes from last year, but above average by about 15%. Total lemon production from the Mediterranean area is estimated at 15.6 million boxes in 1958–59, about 2 million boxes larger than the previous season.

In Italy winter lemon supplies are estimated at 8.7 million boxes. This is about 1½ million boxes more than the previous year.

Preliminary estimates place the Italian summer lemon (or Verdelli) crop at 1.3 million boxes – about 400,000 boxes less than the previous year.

Northern Hemisphere 1958–59 *grapefruit* production will be about 46 million boxes, 6% above last year, but about average.

O.E.E.C. Countries*

Agricultural production in the O.E.E.C. area has increased by 30% compared with pre-war production. During the same period the decrease in agricultural employment has been estimated as 20% for the same area; this results in an increased yield of agricultural production per labour unit (agricultural labour productivity) of approximately 60%.

The reduction in agricultural manpower has been offset, to a large extent, by the increase in employment in industries serving agriculture. The agricultural tractor park, which in pre-war days amounted to roughly 200,000, is now over 2,300,000; fertiliser consumption has doubled when compared with the pre-war period etc.

India

The 1958–59 *rice* crop is unofficially forecast at a record 30,500,000 long tons of milled rice. This is in sharp contrast with the drought-stricken crop of the year before, when only 24,821,000 tons were produced.

The previous largest output was 28,282,000 tons in 1956–57. Favourable weather and high prices are considered to be the main reasons for this season's large crop.

The 1958–59 *tobacco* crop is now forecast at about 672 million lb., compared with 564 million in 1957–58 – an increase of 19%. The area under tobacco rose from 926,000 acres last year to 1,050,000 acres in 1958–59.

Flue-cured tobacco production in 1958–59 is expected to amount to about 139 million lb., up 26% from the 110 million lb. harvested last year. There is a 9% increase in the area planted to flue-cured this season and a substantial improvement in yield per acre is anticipated.

Cashew production, including an estimated 4,000 tons for Portuguese Goa, is forecast as a record 82,000 short tons in-shell for 1959, or about 6% greater than the large 77,000-ton harvest of the preceding season.

Portugal

Despite a heavy rainstorm in the first week of February, which knocked down most of the *almond* blossoms in Algarve Province of Portugal, a good crop next September is considered a definite possibility. Soil moisture is abundant; the trees bloomed profusely following a light 1958 crop, and there is a good set of fruit.

Prospects for the Portuguese *fig* crop are also good. Because of the excellent soil moisture conditions the 1959 crop may be larger than the 1958 drought-stricken crop.

Uruguay

Abnormal rainfall for the time of year continued during January and February. Pastures were in excellent condition, allowing farmers to keep stock longer than is usual.

The Ministry of Agriculture and Livestock has confirmed the damage suffered by the *wheat* and *linseed* crops due to the torrential rains which fell in December. The wheat harvest is now estimated at some 600,000 tons, which, with stocks on hand from the 1956 harvest, now reduces the exportable surplus from the estimated 650,000 tons to 450,000 tons. Linseed is not expected to yield more than 62,000 tons, which, after deducting 15,000 tons for local consumption, leaves a balance of 47,000 tons, or a potential production of some 14,000 tons of linseed oil.

England and Wales

The weather during March was mainly mild and cloudy with intermittent rain or showers. Slight ground frosts were widespread during the month.

Wheat was generally satisfactory, although some loss of colour due to waterlogging on heavier land was reported and damage by slugs made patching necessary in a few areas. *Barley*, *oats* and *rye* made good progress. *Beans* had wintered well and were satisfactory.

In many districts good progress was made on lighter land and cultivations and sowing were more forward than usual; germination was satisfactory. Wet soil conditions delayed progress on heavy land.

Good progress has been made with the preparation of the land for *potato* planting; in some districts most of the early varieties had been planted, and in a few areas the planting of second early and maincrop varieties had begun. The preparation of the land for *sugar-beet* was well forward, except on some heavy soils, and good progress was made with drilling.

Leys sown last year were generally satisfactory and have made good growth; some patchiness was reported where cover crops were badly laid. Other leys were in fairly good condition, except where damaged by poaching, and growth had commenced in most areas. *Permanent pastures* showed signs of growth, except where badly poached.

* Austria, Belgium, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Holland, Norway, Portugal, Sweden, Switzerland, Turkey and U.K.

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